the Petroleum Engineer

AUGUST • 1948

VOLUME XIX NUMBER 12

...ds for Operating Men

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Oct. 14-15—Texas Mid-Continent Oil & Gas Assn, annual meeting, Blackstone, Ft. Worth.
Oct. 22-23—Southern California Meter Assn., Measurement and Control Instrument Exposition, Municipal Auditorium, Long Beach.
Oct. 23-29—American Society of Metals, annual meeting, Benjamin Franklin Hotel, Philadelphia, Pa.
Oct. 25-28—AIME, Metals Division, Hotel Adelphia, Philadelphia, Pa.
Oct. 25-29—American Welding Society, Bellevue-Stratford Hotel, Philadelphia, Pa.
Nov. 8-11—API, annual meeting, Stevens Hotel, Chicago, Ill.

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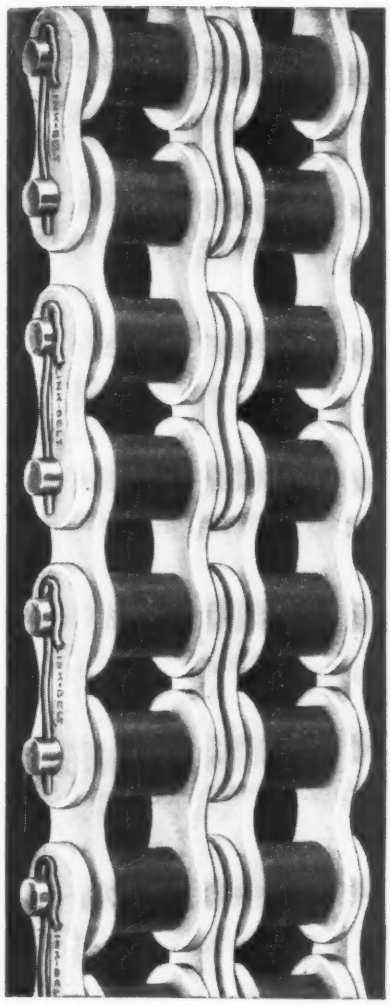

This rig manufacturer says:
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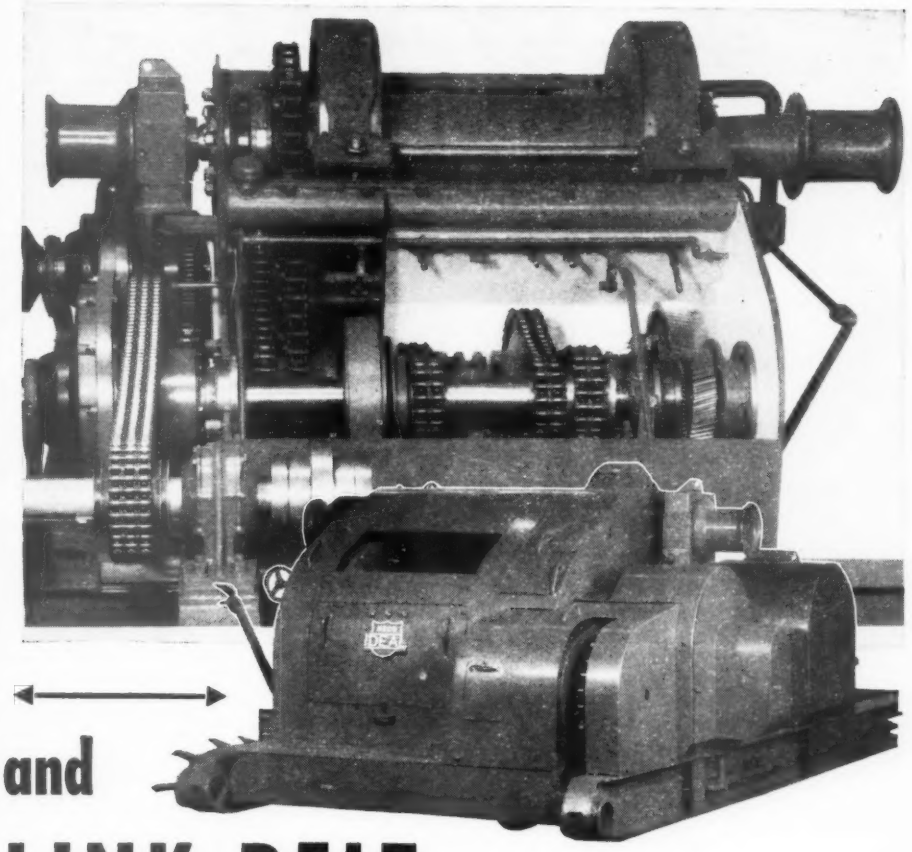

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Yes, National has provided all the necessary design and features . . . including Link-Belt Silverlink Roller Chain throughout . . . in this Ideal Type 50 Consolidated Rig to insure dependable, fast, economical drilling under all conditions.

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Since trouble-free rig performance in the field hinges largely on dependable power transmission, National has standardized on Link-Belt Silverlink Roller Chain for the Type 50 rig. You'll find dependable Link-Belt chain on all other types of National rigs, too.

In fact, throughout the oil industry, Link-Belt Silverlink Roller Chain is more than ever the choice of the oil country . . . with manufacturer and operator alike . . . because Silverlink continues to set the pace in all kinds of service for dependability, long life and trouble-free service.

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LINK-BELT COMPANY
Indianapolis 6, Dallas 1, Houston 2, Los Angeles 33, Kansas City 6, Mo., New York 7, Toronto 8.

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The course of OIL

PRICING SYSTEM CHANGES

The basing point system of pricing, long used by all industry, is in the process of being discarded by the producers of two basic commodities, cement and steel. The reason—rulings of the Supreme Court. Under the basing point price system that has been in force, producers quoted a uniform delivered price to all consumers within a basing point area. This system, according to Federal Government interpretation, is in violation of the anti-trust laws. To avoid conflict with this interpretation, cement and steel manufacturers now quote a price at the mill or factory. The actual freight from the factory to point of delivery is taken care of by the consumer or purchaser.

As both these products, cement and steel, are used in large quantities by every branch of the oil industry, the effect of the changes in the pricing system will be under close scrutiny. Cement and steel, being in relatively limited supply, are still in a seller's market. What will happen when a buyer's market returns, when supply is ample to meet demand, is difficult to contemplate. There is talk of possible action by the new Congress on the pricing question. What action, if any, will be taken? This may depend on trends in pricing during the next few months. By the time Congress reconvenes, industry, including both suppliers and consumers, will have had several months' experience to size up the advantages and disadvantages resulting from a removal of the basing point system.

Because cement and steel are in tight supply, the change in the pricing system will not have the impact that it would be likely to have were the supply and demand picture in balance.

Even under the present changing picture, many complications and difficulties arise that beset both the supplier and consumer. Among these are a revision of quotations and prices on an f.o.b. mill basis on the part of the supplier, and new arrangements at the terminal point of delivery on the part of the consumer or purchaser.

Difficulties in this change of pricing system—if it is to be permanent—must be overcome. The next few months will bring these hardships and problems to the surface.

REPORT ON EUROPE

A glimpse of the outlook for oil refining in Europe was given recently by H. R. Austin, president of the M. W. Kellogg Company, on his return from a trip to petroleum and other industrial areas in Europe.

Of interest is his observation on the progress of the British petroleum industry in converting from a wartime to a peacetime economy. He points out that although "Britain has reached her pre-war capacity, it does not mean her problems are solved. The advance of mechanization has greatly increased the use of petroleum products both at home and on her export markets so now the nation is unable to meet post-war demand with pre-war production."

This shortage, as stated by a British official, "is no longer due to lack of tankers but rather to lack of sufficient refinery capacity."

Although provision is being made for modern refinery processes in all current plans, their inclusion must await the general expansion of British fabricating facilities, such as larger vessels, more heat exchange units, and greater steel capacity. At present, expansion of refinery capacity is confined to processes designed to obtain the greatest volume of products possible with the least use of critical materials.

In June of this year, the refining capacity of France reached 98 per cent of pre-war capacity, and is still much below post-war demand. Capacity for the next 12 months is reported as 200,000 bbl daily. For the next four years a capacity of 345,000 bbl daily is planned. For this 4-year program, 216,000 tons of steel must come from French industry.

Belgium, according to Austin, has under consideration the construction of a modern refinery of 30,000-bbl capacity, to supply its own needs.

Plagued with an acute steel shortage "the problems confronting the British in the refinery expansion program are similar to those facing European industry generally. The primary difficulty is the shortage of steel, and secondarily the scarcity of dollar exchange."

Considering the plight in which Europe's oil refining industry found itself at the end of the war, it has made a remarkable record of progress to date.

—K. C. S.

TALKING THE OIL-MAN'S LANGUAGE

NEW problems in oil well cementing are often encountered and the old ones constantly recur. Making cements to meet these varied and changing conditions requires first-hand information obtainable only from the oil fields.

When considering oil well cements, the operator is interested in such properties and qualities as thickening time, viscosity, strength, rate of dehydration, hydrostatic pressures, etc.

Our oil field Service Engineers maintain field contacts necessary for the development of information. Their services, as well as data developed in the research laboratory and some easy-to-read bulletins on oil well cements, are available at your request. You may have already received the bulletins. If not, we will be glad to send them.

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SCANNING WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON.—The petroleum industry has again weathered threats of government controls and can breathe easier until Congress returns in January, although there may be sporadic oil investigations in the meanwhile.

Most serious threat was the recent ultimatum of high military procurement officers that they would be forced to resort to "mandatory action" unless their requirements of 100-octane and motor gasoline were covered in full, immediately. But the requirements were met—promptly, despite unexpected boosts due to the Berlin airlift.

Now the industry has a voluntary program approved under the Taft Law granting antitrust immunity for cooperative action to deal with oil shortages. Military requirements have top priority under this program. So, there should be no occasion for the military to make use of the new procurement law, which authorizes them to take what they need and negotiate prices later.

● **ASKED OIL CONTROLS.** Oil was one of the "scarce commodities" singled out in President Truman's unsuccessful bid for standby price, rationing, and inventory controls as well as allocation powers. Congress ignored suggestions that Interior Secretary Krug be called to tell about the "need" for oil controls. Later, Truman said Krug "was prepared to submit a program dealing with the proper distribution and prices of coal, heating oil and other fuels." (However, Krug was saved the embarrassment of having to explain to congressional committees how it was that he recommended against oil controls in a report last May to the White House. Krug said then that imposition of oil controls might do more harm than good, especially in view of the fine job the industry was doing voluntarily.)

There was little support for oil controls even in the testimony of other Cabinet officers who did get to testify. Commerce Secretary Sawyer said "the general petroleum situation has improved greatly since the severe shortages encountered last winter." Gasoline supply has proved adequate to meet the sharply increased demands of summer driving and the heating oil outlook appears somewhat better than last year, Sawyer said.

Despite this attitude of two members of his Cabinet (Krug and Sawyer), President Truman was so piqued at Congress' refusal to vote controls he told newspapermen that nothing whatsoever could be done (without controls) to avert another fuel oil shortage on the East Coast this winter.

At the very moment when Truman was so replying to a newspaperman's question, another member of his Cabinet, Attorney General Clark, was drafting a letter of approval for the industry's proposed voluntary oil agreement. Under this program, district committees are being set up under the National Petroleum Council to make recommendations for adjusting refinery yields and for more effective distribution of products so as to prevent hardship among consumers. With an improved supply outlook (barring military emergencies), industry leaders believe that this program will be all that is needed to deal with any shortages developing.

The industry has been warned, however, that it faces oil rationing if the voluntary program does not succeed in solving the situation. Such warning came not from the White House but from the House Military Oil Committee, headed by Congressman Dewey Short (Rep., Mo.), in a report signed by all eleven members, Republicans and Democrats alike.

● **NATIONAL OIL POLICY.** President Truman has rejected another recommendation by Congressman Short's committee, namely, the establishment of a presidential commission to draft a national oil policy. (It was feared in some industry quarters that this might bring on recommendation for federal oil control.) Truman's reason for not adopting this recommendation, he advised Short, was that various government agencies are already at work on elements of a national oil policy.

A straw in the wind on national oil policy was contained in Commerce Secretary Sawyer's statement on export controls during the recent special session of Congress. "As the U. S. is producing almost two-thirds of the world's petroleum output with less than one-third of the known reserves—and probably considerably less than one-third of the reserves still to be discovered—it is clear that the U. S. will become increasingly dependent upon foreign sources of crude oil. It is even more essential that the dependence of Europe and other areas upon the Western Hemisphere for petroleum supplies be reduced. At the present time, the Western Hemisphere is supplying roughly 75% to 80% of Western Europe's import requirements, and the Middle East, 20% to 25%. With the expansion of projects now under way in the Middle East, it is expected that these proportions will be reversed. Until this happens, it is of the utmost importance to maintain control of petroleum exports."

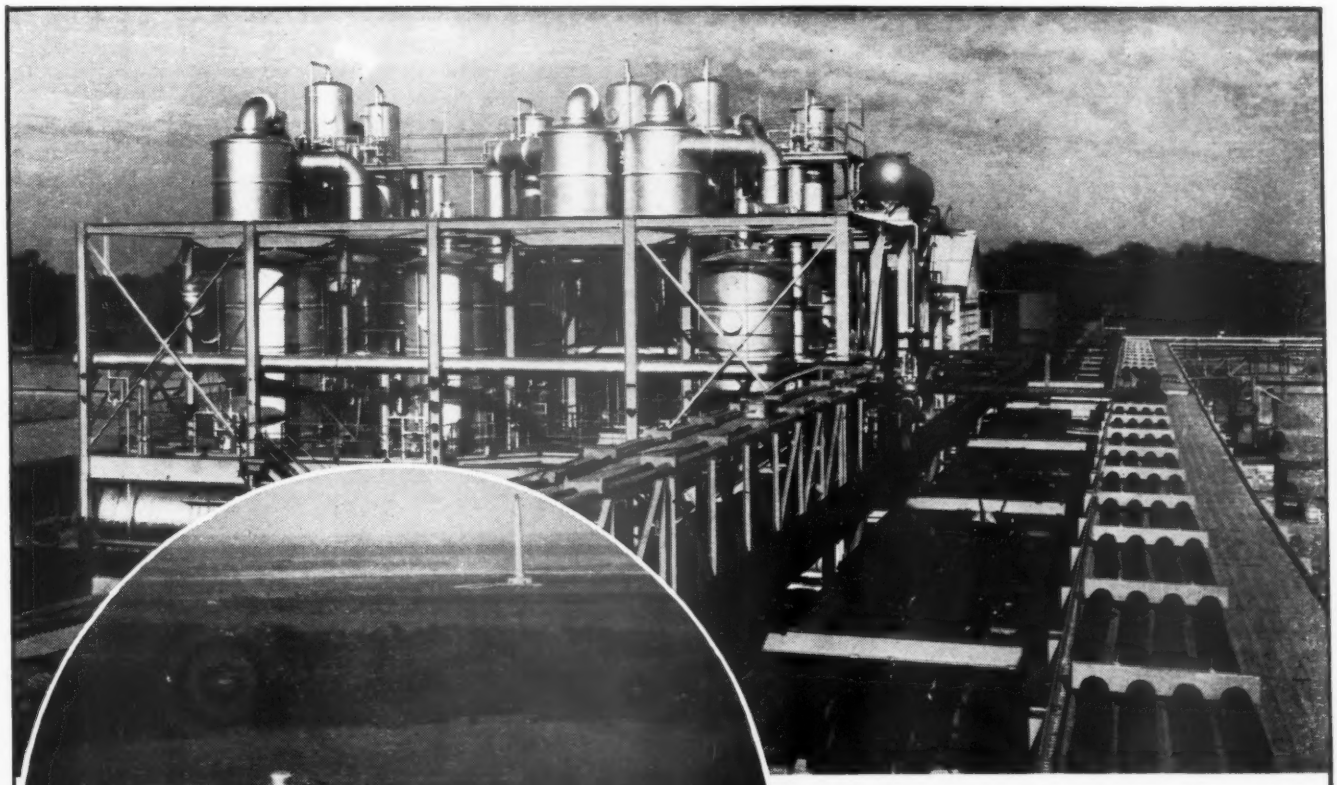
This is the refrain heard so frequently in any discussion of oil policy. It is expected to be reiterated in recommendations of the National Security Resources Board, which may include also an elaboration on the DeGolyer idea of bringing in foreign oil and trading it for domestic oil in place. To this may be added a suggestion for some sort of subsidy to producers for holding back production in new fields.

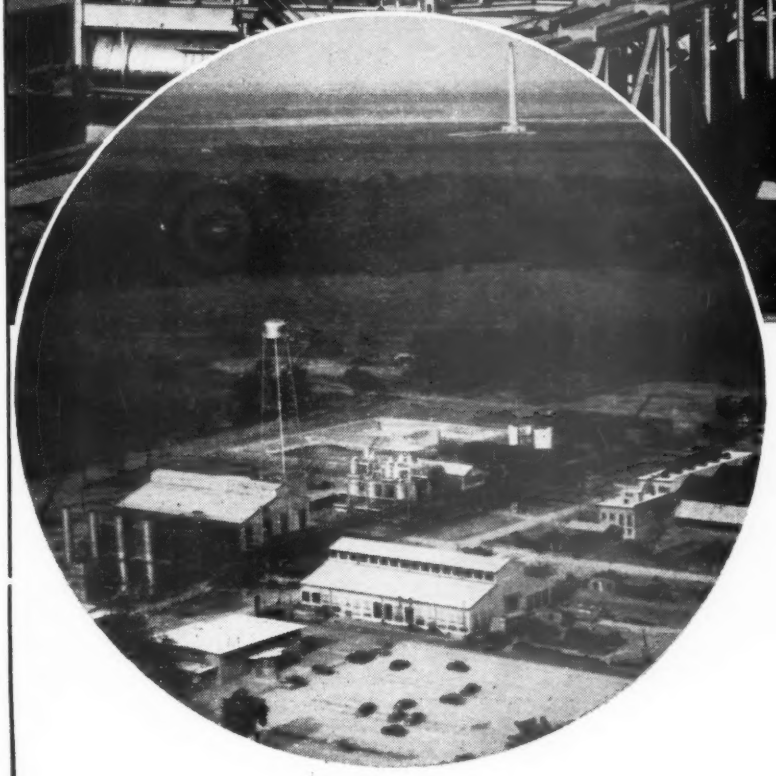
● **STOCKPILE PROPOSALS.** Another idea on stockpiling was presented at the recent NPC meeting by Bruce K. Brown (Indiana Standard), chairman of the Military Petroleum Advisory Committee. Brown suggested that a military reserve of products could be built up at the rate of 100,000 bbl a day, with tankage located in isolated areas but along civilian transportation lines. Distillate fuels would be the most logical product to store because they do not deteriorate and would be available to meet heavy demands for diesel and jet fuels in case of war as well as providing charging stock to make aviation gasoline. Alkylate is another strategic material in short supply but any program would have to provide for turning over stocks to keep them fresh. Brown had in mind that the government would finance the building of such storage.

Congressman Short is insisting that the armed services submit at the next session a program for stockpiling military oil. So, these and other items will be chewed over in the months ahead.

Meanwhile, the National Petroleum Council has set up a national oil policy committee, headed by A. Jacobsen (Amerada) to revise the policy statement of Jacobsen's committee under the Petroleum Industry War Council. A report has been promised for the October 14 meeting of the NPC.

● **MEXICAN SPLIT TOO LOW.** Prodded again by the military, the State Department plans to send Robert Eakens, chief of its petroleum division, to Mexico City to see if the government there will not come through with more liberal terms for re-entry of American oil operators into Mexico. Development of Mexican oil resources is a "must" in the hemispheric defense plan, according to military leaders. Last winter, Petroleos Mexicanos, the government company, suggested an 80-20 split after an operator had recovered his drilling costs but that aroused little response among Americans who thought a 50-50 split would be more in keeping with the risk involved.





WE'RE PROUD OF DIAMOND'S NEWEST CHEMICAL WORKS

Diamond Alkali Company's newest chemical plant, the Houston Works on the Houston Ship Channel, recently went on stream, manufacturing chlorine and caustic for what it's able young president, R. F. Evans, so aptly described as "the living, growing, expanding chemical industry." Brown & Root, Inc. are proud to have been selected for engineering and construction of this great plant—proud of the part we have in the process industry in the Southwest, which is fast securing its position as a world chemical capital.

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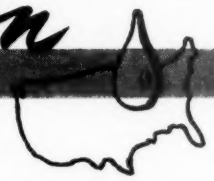
national petroleum situation



By H. J. STRUTH*,
Petroleum Economist

IMPROVED STOCK LEVELS. Stocks of all refined oils on August 1, were 16 per cent above the same date last year. Improvement in stock levels is marked by the fact that they currently represent 52 days supply, against 47 days supply a year ago. Motor fuel stocks are 18 per cent above last year and represent 35 days supply, against 33 days last year. Fuel oil stocks are 22 per cent greater; represent 57 days supply, against 48 days last year. Stocks of all oils have been increased since January 1, by 34,658,000 bbl, whereas during the same period last year they were reduced 7,210,000 bbl.

*Editor, *The Petroleum Data Book.*

MORE CRUDE OIL. While the crude market continues to be a "tight" affair, the supply of crude oil is shown to be 11 per cent greater than last year. Daily crude supply, including imports, in the first 7 months of 1948 averaged 5,750,000 bbl, against 5,215,000 bbl last year. Analysis shows that supply and demand have been in close balance this year, despite the sharp increase in production and the influx of substantially greater quantities of foreign crude oil. Domestic production dropped slightly in July to a daily average of 5,520,000 bbl, but this was 10.7 per cent above a year ago. All states, except Illinois, reported increased crude production over last year.

PRICES HOLD STEADY. Crude prices continue to hold at a steady level and late reports indicate a slackening in offers of premium prices. Efforts of the industry to "hold the line" have been successful and it is likely now that prices will hold at present levels throughout the balance of this year. Refiners are not in a position to pay more for crude and the industry as a whole harbors no desire to lift the general price level of refined products to the public in order to compensate for any further advances in crude oil prices.

DRILLING CONTINUES UPWARD. All areas, except Mississippi, have reported sharply increased drilling activity. Well completions in the first 7 months of this year were 17 per cent above last year. Louisiana, California, Texas, and Kansas report increases this year over last year of from 24 per cent to 56 per cent. Wildcat drilling is 22 per cent greater than last year; all states report substantial increases except Illinois and Mississippi.

Comparative Statistics, July, 1948

*All figures are computed on a Bureau of Mines' Basis**

	July 1948(P)	June 1948(P)	July 1947	This year to date	Last year to date	Per cent change
Wells drilling	4,760	4,700	4,350	4,760	4,350	+ 9
Total wells drilled	3,499	3,268	3,307	21,106	18,148	+16
Development wells	2,732	2,603	2,582	16,518	14,229	+16
Oil	1,818	1,788	1,713	11,538	9,555	+21
Gas	239	214	315	1,360	1,789	−24
Dry	675	601	554	3,620	2,885	+28
Per cent dry	24.7	23.1	21.5	21.9	20.3	+ 1.6
Service wells	173	164	224	1,207	1,137	+ 6
Wildcat wells	594	501	501	3,381	2,782	+22
Oil	117	78	78	525	428	+23
Gas	21	24	20	147	106	+39
Dry	456	399	403	2,709	2,248	+21
Per cent dry	76.8	79.6	80.5	80.1	80.8	− 0.7
Crude supply‡	181,110	176,390	166,531	1,224,694	1,105,491	+11
Daily average	5,842	5,880	5,372	5,750	5,215	
Crude demand‡	183,060	176,070	173,056	1,225,660	1,099,485	+11
Daily average	5,905	5,869	5,582	5,754	5,186	
Crude stocks	229,688	231,638	236,182	229,688	236,182	− 3
Days supply	39	39	42	39	42	
Natural gasoline production	12,100	11,700	10,969	83,120	73,907	+12
Daily average	390	390	354	390	349	
Motor fuel production	81,550	78,540	73,494	527,085	468,340	+13
Daily average	2,631	2,618	2,370	2,475	2,209	
Gasoline yield, per cent	41.1	41.2	40.3	39.8	39.8	0
Motor fuel demand‡	86,474	81,660	77,768	517,432	475,618	+ 9
Daily average	2,789	2,722	2,509	2,429	2,243	
Motor fuel stocks◇	97,130	102,054	82,338	97,130	82,338	+18
Days supply	35	37	33	35	33	
Fuel oil production	71,280	68,750	64,820	503,462	425,766	+18
Daily average	2,299	2,292	2,091	2,364	2,008	
Fuel oil demand‡	62,461	63,900	61,172	527,836	491,975	+ 7
Daily average	2,015	2,130	1,973	2,478	2,321	
Fuel oil stocks	115,030	100,149	94,044	115,030	94,044	+22
Days supply	57	47	48	57	48	
Refinery still runs	176,300	169,470	161,844	1,176,490	1,041,976	+13
Daily average	5,687	5,649	5,221	5,523	4,915	
All refined stocks	305,770	292,593	263,702	305,770	263,702	+16
Days supply	52	49	47	52	47	

*Unless otherwise stated all figures represent thousands of barrels.
‡Total demand, including exports.
(P)—Preliminary.
◇Includes finished and natural gasoline.
‡Includes domestic production and imports.
¶Revised.

Supply and Demand—All Oils

	July 1948(P)	June 1948(P)	July 1947	This year to date	Last year to date	Per cent change
Total supply, all oils	197,440	192,620	182,174	1,344,045	1,217,661	+10
Daily average	6,369	6,421	5,877	6,310	5,744	
Total demand‡, all oils	186,213	181,380	178,951	1,309,387	1,224,871	+ 7
Daily average	6,007	6,046	5,773	6,147	5,778	
Change in stocks (total)	+11,227	+11,240	+3,223	+34,658	−7,210	

Current Crude Oil Prices

U. S. average	$2.61	Louisiana	$2.62
Texas	2.61	Arkansas	2.43
California	2.42	New Mexico	2.40
Oklahoma	2.63	Mississippi	2.42
Kansas	2.62	Illinois	2.76
		Other states	3.15

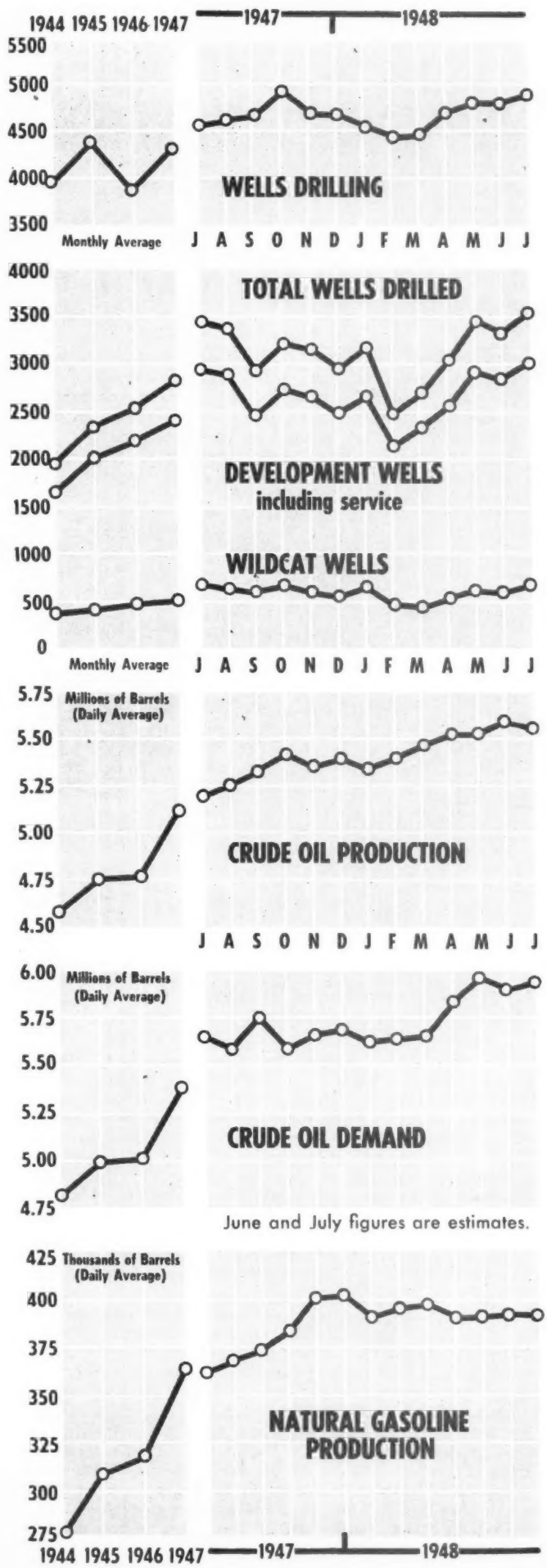
Basic crude prices:

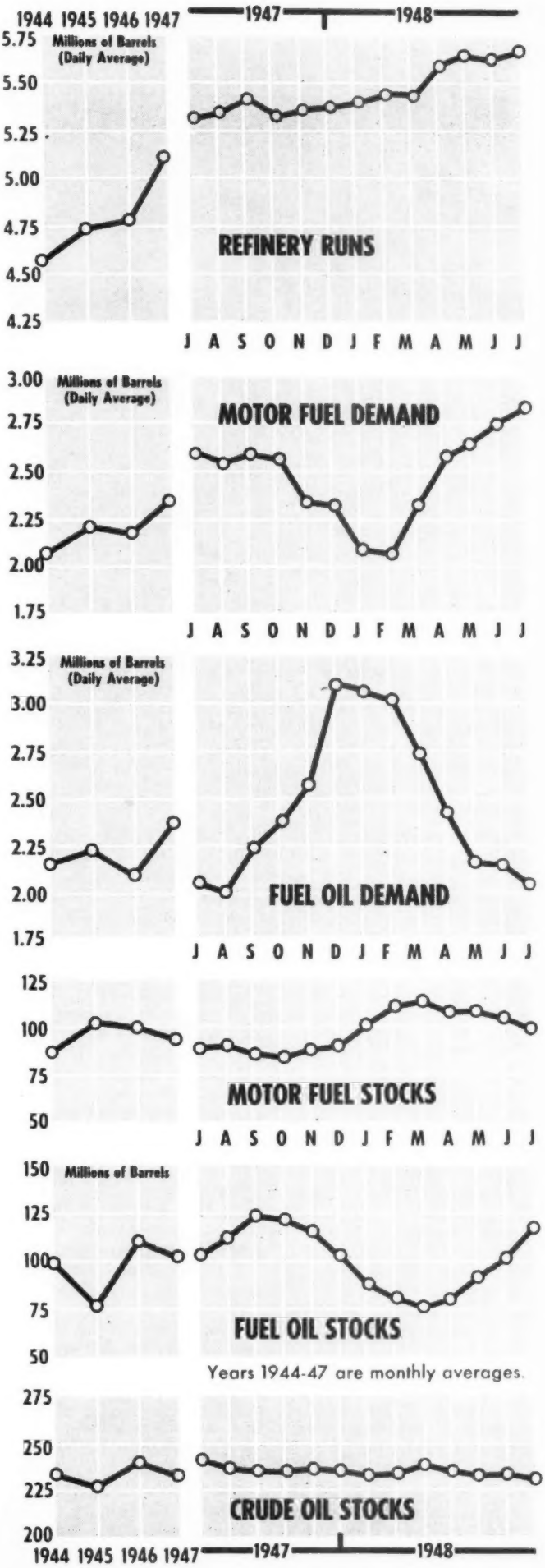
Oklahoma-Kansas (36 gr.)	$2.57
Texas Gulf Coast (36 gr.)	2.86
East Texas	2.65
West Texas (36 gr.)	2.44
California Signal Hill (26 gr.)	2.41
Pennsylvania, Bradford	5.00

Drilling and Production Statistics by States

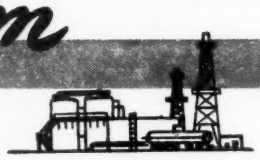
	July 1948(P)	June 1948(P)	July 1947	This year to date	Last year to date	Per cent change
Wells drilled (excl service)	3,326	3,104	3,083	19,899	17,011	+17
Arkansas	20	19	21	165	163	+ 1
California	242	247	162	1,645	1,130	+46
Illinois	246	229	190	1,279	1,107	+16
Kansas	294	298	247	1,719	1,383	+24
Louisiana	234	204	186	1,259	809	+56
Mississippi	35	32	52	224	282	−21
New Mexico	51	48	42	354	310	+14
Oklahoma	343	363	334	2,284	2,223	+ 3
Texas	1,116	985	1,038	6,564	5,291	+24
Other states	745	679	811	4,406	4,313	+ 2
Wildcats drilled (incl above)	594	501	501	3,381	2,782	+22
Arkansas	6	10	6	52	35	+49
California	49	43	34	237	204	+16
Illinois	49	26	57	215	246	−13
Kansas	53	48	45	277	219	+26
Louisiana	29	31	31	163	154	+ 6
Mississippi	7	4	8	49	53	− 8
New Mexico	6	7	2	35	26	+35
Oklahoma	68	71	67	471	453	+ 4
Texas	250	200	179	1,414	1,019	+39
Other states	77	61	72	468	373	+25
Daily crude production	5,520	5,546	5,137	5,442	4,949	+10
Arkansas	85	87	82	86	81	+ 6
California	948	952	918	942	907	+ 4
Illinois	172	172	180	173	185	− 6
Kansas	308	309	296	298	283	+ 5
Louisiana	495	488	439	484	427	+13
Mississippi	124	121	96	120	90	+33
New Mexico	132	131	109	129	106	+22
Oklahoma	427	432	389	414	377	+10
Texas	2,455	2,482	2,283	2,432	2,164	+12
Wyoming	151	147	118	145	115	+26
Other states	223	225	227	219	214	+ 2

Preliminary estimates based upon data supplied by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.


1944 1945 1946 1947
1947
1948
5500
5000
4500
4000
3500
WELLS DRILLING
Monthly Average
J A S O N D J F M A M J J
4000
3500
3000
2500
2000
1500
1000
500
0
TOTAL WELLS DRILLED
DEVELOPMENT WELLS
including service
WILDCAT WELLS
Monthly Average
J A S O N D J F M A M J J
5.75
Millions of Barrels
(Daily Average)
5.50
5.25
5.00
4.75
4.50
CRUDE OIL PRODUCTION
J A S O N D J F M A M J J
6.00
Millions of Barrels
(Daily Average)
5.75
5.50
5.25
5.00
4.75
CRUDE OIL DEMAND
June and July figures are estimates.
425
Thousands of Barrels
(Daily Average)
400
375
350
325
300
275
NATURAL GASOLINE
PRODUCTION
1944 1945 1946 1947
1947
1948


1944 1945 1946 1947
1947
1948
5.75
Millions of Barrels
(Daily Average)
5.50
5.25
5.00
4.75
4.50
4.25
REFINERY RUNS
J A S O N D J F M A M J J
3.00
Millions of Barrels
(Daily Average)
2.75
2.50
2.25
2.00
1.75
MOTOR FUEL DEMAND
J A S O N D J F M A M J J
3.25
Millions of Barrels
(Daily Average)
3.00
2.75
2.50
2.25
2.00
1.75
FUEL OIL DEMAND
J A S O N D J F M A M J J
125
100
75
50
MOTOR FUEL STOCKS
J A S O N D J F M A M J J
150
Millions of Barrels
125
100
75
50
FUEL OIL STOCKS
Years 1944-47 are monthly averages.
275
250
225
200
CRUDE OIL STOCKS
1944 1945 1946 1947
1947
1948

highlights in oildom



● **REWRITING CONSERVATION LAW.** The Interstate Oil Compact Commission's comprehensive oil and gas conservation law is being re-written and it is expected that the revised draft will be ready for use of state legislatures convening in 1949, it is announced by Earl Foster, Commission executive secretary and chairman of the legal committee. Task of re-writing the law has been assigned to a subcommittee of the legal committee, which laid out the framework of the new material at a three-day session in Santa Fe, New Mexico, recently. T. Murray Robinson, Oklahoma City attorney, chairman of the subcommittee, reports that excellent progress was made at the Santa Fe meeting and that a report will be made to the legal committee and Commission at the New York meeting, August 30-September 1, although the committee bill will not be in form for presentation by that time.

At the Santa Fe meeting, the subcommittee was primarily concerned with drafting of proposals relating to agreements authorizing unit operations, statutory authorization for orders providing for unitization, well spacing and the pooling for drilling of a well or wells in a drilling unit, and production control and the allocation of production.

● **NO WEST COAST SHORTAGE SEEN.** A study of recent reports of the U. S. Bureau of Mines verifies the opinion of oil men that petroleum demands on the West Coast can be met through 1948 without shortages. This does not mean that supplies will be so ample that consumers may be prodigal in their use of gasoline this summer or heating oils next winter. It does mean that with proper restraint to avoid waste and extravagance, there is good assurance that even the currently high level of demands can be met without hardship or rationing.

The production of crude oil in California has now reached 955,000 bbl per day and is still rising. It is expected to reach 960,000 bbl per day by the end of the year. Discoveries of real importance in the Cuyama Valley and at Lost Hills may boost the average still higher. Production in prewar years was 600,000 to 650,000 bbl per day, and domestic consumption was able to utilize only about three-fourths of it. Domestic consumption has doubled since then, and still there are sufficient supplies to permit exporting between 5 and 10 per cent of the total to Canada, Hawaii, and other Pacific areas.

The total supply of raw materials and products, including some small imports of lubricating oil and other commodities from the Mid-Continent and Rocky Mountain areas, is running 4 per cent above last year. The total demand, on the other hand, is running only 2 per cent higher, and therefore, stocks are increasing a little.

Total petroleum stocks on the West Coast at the beginning of this year were about 90,000,000 bbl. By the end of the year they are likely to reach 100,000,000. At first glance this looks like a comfortable increase, which, of course, it is. Prior to the war, when surplus oil caused excessive stock levels, they reached a peak of 164,110,000 bbl in 1939. Considering the greatly increased volume of business, a level of 100,000,000 bbl now is barely comfortable.

Most of the oil being added to inventories is heavy residual fuel of a kind unsuited to home heating. The balance of supply and demand for light fuel, as well as for motor fuel, is a delicate one. Although a balance seems reasonably sure at this time, unforeseen developments in the form of military demands on one hand, or large new discoveries of gasoline-bearing crude on the other, might change the outlook in one direction or the other in a matter of months.

Gasoline demands are running 4 or 5 per cent above last year and show some signs of leveling. Early reports on summer automobile traffic indicate that vacation travel so far this year is not much above last year. It is too soon to say whether a heavier rush will come later in the summer, but it is widely anticipated.

Residual fuel demands are 7 to 8 per cent *below* those of last year. There are two principal reasons for the drop. First, the long-delayed spring rains replenished the storage behind dams where electric power is generated. Second, more natural gas is available this year, both from local supplies and from West Texas.

● **COMPACT MEETING.** Panel discussion of state responsibility and action toward assuring an adequate petroleum supply, participated in by governors of the leading oil and gas producing states, will be a feature of the Interstate Oil Compact Commission meeting in the Roosevelt Hotel, New York City, August 30 to September 1, Governor Beauford H. Jester, Compact chairman, announces. Indications are that as many as ten governors will take part in the panel.

Senator George W. Malone of Nevada, consulting engineer, will analyze the oil production possibilities of the nation. Speaking on the subject, "Are We Running Out of Oil?", the Nevada Senator will discuss the nation's proved and potential petroleum reserves.

Governor Thomas E. Dewey, Republican presidential nominee, will discuss interstate cooperation in his address welcoming the Compacters to New York.

Governor Frank Carlson of Kansas will speak on cooperative action in interstate oil and gas fields, showing how the states have worked together in establishing producing procedures in fields lying within two or more states, such as the Hugoton field in Kansas, Oklahoma, and Texas, the Rodessa field in Texas and Louisiana, and the Rhodes field in New Mexico and Texas.

Colonel Ernest O. Thompson, chairman of the Texas Railroad Commission and a former chairman of the Compact, will answer critics of the Compact and regulatory bodies, showing how cooperative action of the oil producing states has made it possible to supply the present unprecedented demand for petroleum products.

William J. Murray, Jr., Texas Railroad Commission member, will discuss spot shortages of specific petroleum products, pointing out especially why there was a shortage of butane in Texas last winter.

● **OIL-SHALE DRILLING IN COLORADO.** Industry and government have joined forces informally in a coordinated program of exploratory drilling and assay work to determine the character and extent of western Colorado's immense oil shale beds, James Boyd, director of the Bureau of Mines, announces. At least 11 diamond core drill holes are scheduled to be sunk this summer in the Green River formation—said to be the world's largest single mineral deposit. The areas to be drilled are immediately northwest of the towns of Rifle and Grand Valley, Colorado. Four or more holes are planned by the Union Oil Company of California, and seven by the Bureau of Mines acting for the Department of the Navy. In addition, the Pacific Oil Company—a subsidiary of the Standard Oil Company of California—is carrying on geological and assay work to evaluate its properties northwest of the neighboring town of DeBeque, Colorado.

All government-sponsored drilling will be done under contract on Naval Oil Shale Reserve No. 1, where the Bureau of Mines now is operating an oil-shale demonstration plant and an experimental mine under its synthetic liquid fuels research and development program. Through a transfer of funds, the Navy Department has made available to the Bureau of Mines $144,000 for the drilling and necessary core assay work, Director Boyd said. Assays will be made at the Bureau's Petroleum and Oil-Shale Experiment Station at Laramie, Wyoming. Each of the seven holes tentatively will be drilled to a depth of 1500 ft.

All core-drilling operations and other exploration sponsored by private oil companies will be conducted on properties that they hold in the area.

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OF THE

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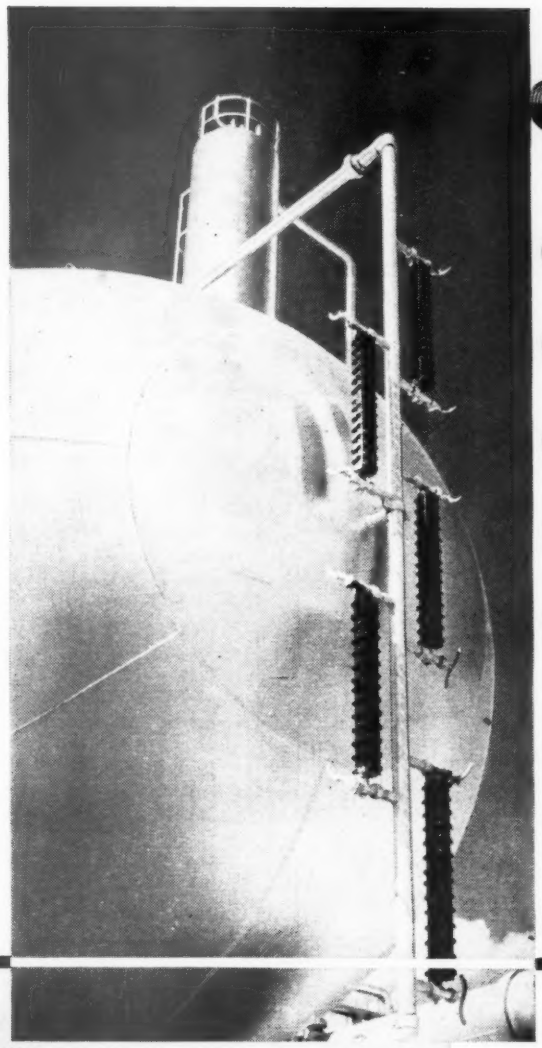

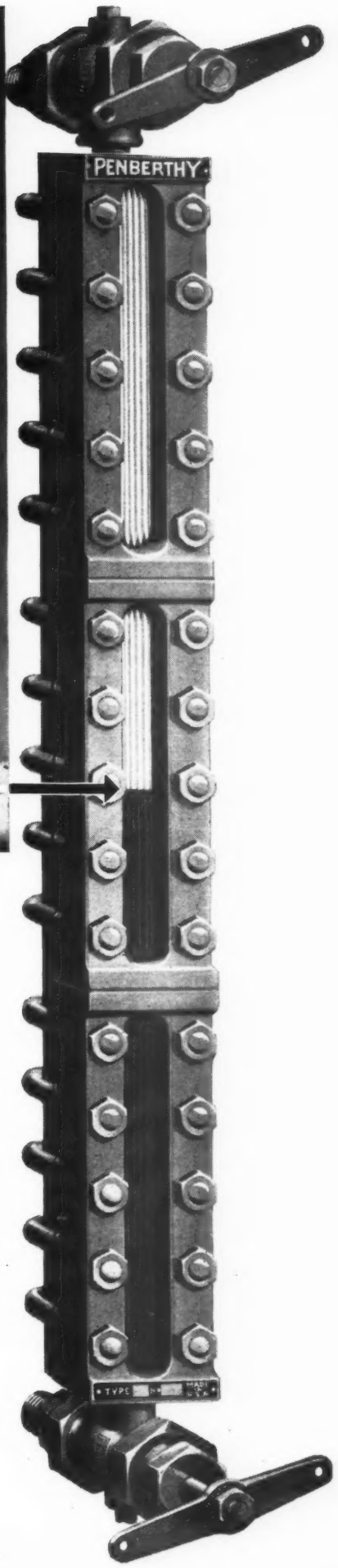

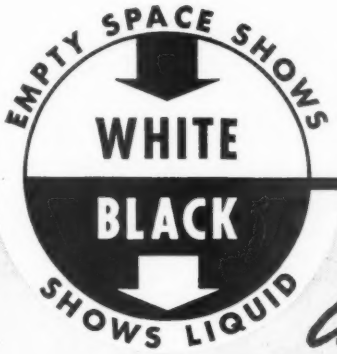

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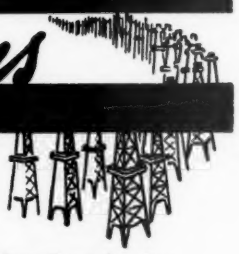
current oil field operations



Exploration wells that have found production.

● **LOUISIANA.** Barnsdall 2 Edgewood 14-6s-10w Beauregard. 140 B cond. daily from 8456-63 ft.

Gravis and Mitchell 1 Goston 7-9s-2e Bayou des Glaise field, Iberville. 500 B cond. daily from 11,015-45 ft. New sand.

Gulf 28 Delta Securities 18-15s-22e, Bayou Couba field, Plaquemines. 165 BOPD from 3799-803 ft. New sand.

Kerr-McGee 2-32 State, Ship Shoal area, off Terrebonne. 325 B oil in 12-hr from 2808-24 ft. New sand.

J. C. Hawkins et al 1 Young 10-7s-2w Acadia. 95 B cond daily 8530-36 ft.

Roesser and Pendleton 1 Columbia Land 27-6s-13w Beauregard. DST 2000 ft oil from 7571-81 ft.

H. L. Hunt 1 Edwards 78-2s-4e Avoyelles. 250 BOPD 45° from 7926-32 ft.

Magnolia 1 State-Ship Shoal, 1se 766, blk 72, Terrebonne. 3550 MCF gas daily from 7306-08 ft.

Barnsdall et al 1 Davis Lumber 7-16-4w Driscoll field, Bienville. 28 B cond and 4060 MCF gas daily Pettit 6760-800 ft and 6810-40 ft. New sand.

Humble 1-A Grand Isle, Gulf of Mexico off La Fourche. 840 B 30.7° oil in 12-hr from 8640-65 ft.

● **KENTUCKY.** F. T. Shelton and Ashland 1 Ramsey 21-M-22 Webster. 1-hr DST gas and 1750 ft oil O'Hara lime.

● **SAUDI ARABIA.** Arabian American well at Ain Dar, 27 miles west of Abqaiq. 250 ft oil sand 6650-900 ft.

● **WYOMING.** Continental 1 Alice Coles NW NW SE 17-42n-78w Johnson. 241 BOPD 39.3° Lakota 7726 ft.

Sinclair Wyoming 2 Drayton Cons. NE SE 3-26n-90w Lost Soldier field, Fremont. 720 BOPD Cambrian 5985-6026 ft.

● **OKLAHOMA.** F. A. Callery and H. Hurt 1 Blumer, Payne. 50 BOPH Skinner 4321-372 ft.

Carter 1 I. L. McDaniel CNW SW 8-4-3w Garvin. 872 BOPD from 9612 ft.

Carter 1 Bradshaw-Watkins CSE NE 4-4-3w Garvin. 1¼-hr DST 20 BOPH and 250 MCF gas daily Gibson 7112 ft.

Warren 2 Keyser SE SE SW 5-21-1w Noble. 9 BOPH from 3832 ft.

Continental 1 Maruska SE SE SW 16-10n-4w, Cleveland. 202 BOPD Bois d'Arc 8145-250 ft.

W. and N. V. Duncan 1-A Keyes SE SE SW 11-11n-8e Dill field, Okfuskee. 15 BOPH Hunton 3929 ft.

F. B. Murta 1 Ida Ellis SE NW SE 6-9n-11e Hughes. DST 5000 MCF gas Cromwell 3060-105 ft; DST 150 ft oil Hunton 3745-90 ft.

C. L. Carlock 1 Tuley NE NE SE 12-1n-1w Garvin. 155 B oil in 14 hr Deese 4496-516 ft.

Warren 1 Whitmer SW NE SW 8-21-1w Noble. 351 B oil in 14-hr. Marshall 5214-22ft.

Texas 1-G School Land NE SW NW 25-4-3w Garvin. 149 B 43° oil in 6-hr Second Bromide 7616-32 ft.

Phillips 1 Bertha C. Hillman NW SW SW 3-2-2w Garvin. 50 BOPH Gibson 6550-75 ft.

British-American 1 Corneil NE NE NW 24-28n-3w Grant. 178 BOPD 43° Wilcox 4683-93 ft.

● **ARKANSAS.** Phillips and assoc. 1 Scales CNE SW 3-18s-17w Union. 26 BOPH 39.3° oil Smackover 7760-68 ft.

● **NEW MEXICO.** Richfield 1 Comanche Unit 24-11s-26e Chaves. 24 BOPD Silurian 6116-52 ft.

● **MEXICO.** Pemex 1 Reynosa, near northern Mexican border. 1000 BOPD 50° from 7075-78 ft.

● **MISSISSIPPI.** Humble 2 E. R. Ford et al 13-1n-8w, Marion. 75 B 53° cond and 4200 MCF gas daily 9037-39 ft, 8979-94 ft, and 8997-9002 ft.

● **TEXAS.** Continental 1 S. W. Kennedy 27-ET Montague. 464 BOPD Bend conglomerate 6180-218 and 6226-65 ft.

Seaboard 1 Hinson, Terry. 1½-hr. DST 6100 ft oil from Pennsylvanian 9405-9428 ft.

Gulf 123-E Keystone, Winkler. 165 BOPD 34.6° Tubb lime 6400-600 ft.

Magnolia 7 Warren Ranch, Harris. 165 BOPD Miocene 3063-66 ft. New sand.

Smith and Donkin 1 Mach 25-ETRR, Wharton. Gas and cond. from 6826-30 ft.

T. D. Humphrey 1 Tuggle, Fitzgerald sur, Kaufman. 68 BOPD Bacon lime 6106-16 and 6132-42 ft.

R. Lacy et al 2-A Cox, Barfield sur, Quitman field, Wood. 14.8° oil from Woodbine 4350-59 ft. New sand.

Stanolind 1-D Cowden 40-43-2s Ector. 214 BOPD Canyon 9224 ft.

Sun 1 Bentsen, El Benadito grant, Hidalgo. 53 BOPD 47° from 5967-9 ft.

Lynn 1 Jack Neale, blk 2 BS&F sur, Archer. 70 BOPD Mississippi 5198-208 ft.

Gulf 8-E Wrister Bros. CSW SW 2-5-HT&C Ward. Swb 82 B oil in 7½ hr Ellenburger 8980-98 ft.

Lester & Duffield 1 Odom 964-TE&L, Throckmorton. 87 BOPD from 2549-551 ft.

Pan American 1 Paul Lang, James Duff league, Cottonwood Creek field DeWitt. 3 BOPH from 7625-26 ft. New sand.

Danciger 1 Baass, Victoria. 39,000 MCF gas daily from 4618-20 ft.

Placid 1 Winfree, C. West sur, Orange. 320 BOPD from 7710-15 ft.

Standard of Texas 1 Greene, Thompson sur, Milam. 75 BOPD 30° from 5697-705 ft.

Warren 1 Sweeney TE&L, Young. 90-min. DST 15 BOPH from Bend conglomerate 4304-10 ft.

R. J. Caraway 1 Sessions, Musquez sur, Cherokee. 25-50 BOPH 40° Woodbine 4402-04 ft.

Standard of Texas 1 New Birmingham Dev. Co., Cherokee. 107,000 MCF gas and 14½ B oil daily, Rodessa.

Cities Service 1 Sealy, blk 3, GH&H sur, Wise. 621 BPOD Chico Bend conglomerate 5306-40 ft and 5350-56 ft.

S. G. Harrison 1 H.P. Stockton, sec 7, IRR sur, Wharton. 7-min DST 1000 ft 24° oil Greta 4100 ft.

Sun 3 G. P. Day, Crownover sur, Madison. 4 BOPH 25.1° from 1903-08 ft and 2023-27 ft.

Texas 1 Hanks, W. Allbright sur, Blackfoot field, Anderson. DST 4000 ft oil Travis Peak 9960-10,000 ft. New sand.

W. H. Hammon and Warren 1-A Cole, blk 10, Palo Pinto school lands, Wichita. Oil from KMA sand 3950 to 4042 ft.

Grace and Grace 1 Greer, blk 29, Grayson county school lands, Clay. 25 BOPD 43° Caddo 5722-52 ft.

British-American 1 Smith, J. Colston sur-212, Haskell. 46 BOPD from 5315-37 ft.

Ungren & Frasier et al 1 Milliorn, sec 20-BBB&C, Callahan. 94.46 B oil in 11-hr.

F. M. Manning, 3-B Moore, TE&L sur Stephens. 150 BOPD from 3319-24 ft.

● **KANSAS.** Alpine Oil & Royalty 1 Douglas CE½ SE NW 23-34-2w Sumner. 30-min. DST 750 ft gas from Wilcox 4474-4480 ft.

Texas 1 Trester SW SW SW 21-18-13w Barton. 28 BOPD Arbuckle.

Veeder Supply and Development 1 Hampton SE SE SW 27-29-5e Butler. 50 BOPD 42° Bartlesville.

Bay 1 Hunter SW SW SW 4-8-17w Rooks. 34 BOPD Arbuckle 3389 ft.

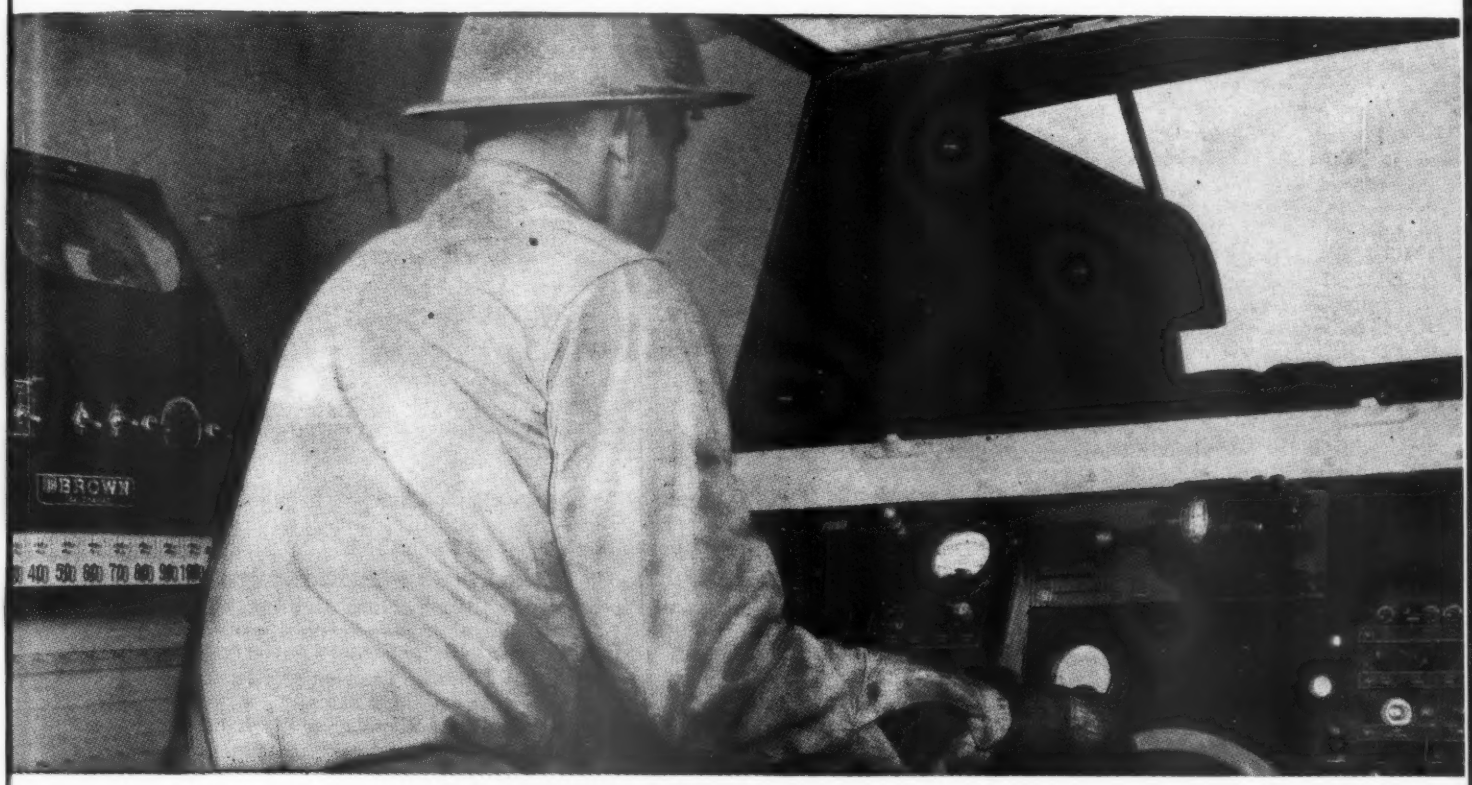
W. L. Hartman 1 Westhusin SW SW SW 31-9-17w Rooks. 20 BOPD Lansing 3477-83 ft.

Cities Service 1 Krueger SE SE SE 35-10-16w Rooks. Swb 110 B oil in 12-hr Lansing lime 3372-544 ft.

Delta Production and Bennett & Roberts 1 Hildebrand NW NW 2-24-12w Stafford. 32 BOPD and 500 MCF gas daily Viola 3792-3800 ft.

Looking for a "Dam Site"!

The successful shut-off of water in producing wells depends on the accurate location of the points of entry—and the application of suitable plugging materials.



Interior of an Electric Pilot truck showing the instruments which enable Dowell Engineers to "look" into the bottom of a well.

Dowell's Water Locator finds points of water entry

Dowell's Plastic Service provides effective control

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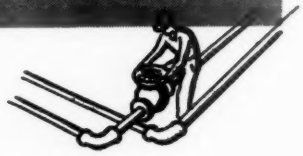
pipeline developments



● **TEXAS EASTERN PLANS BIG EXPANSION.** Texas Eastern Transmission Corporation, Shreveport, Louisiana, owners and operators of the Big and Little Big Inch pipe lines, applied to the FPC for authority to perform construction that would increase its deliveries of natural gas to consumers in the East by 235,000,000 cu ft daily and bring the total sales capacity of its pipe line system to 740,000,000 cu ft per day.

The increase in deliveries would be brought about as a co-operative effort with Texas Gas Transportation Corporation.

Texas Eastern will spend $24,000,000 in additional construction, looping of lines, and addition of compressor horsepower to accomplish the increased deliveries. The money would be derived from the sale of additional bonds or other funded debt, the application stated.

Included in the new construction would be a 100-mile 16-in. line to the Provident City Field in Lavaca County, Texas, from the company's present terminus at Baytown, Texas. Grant of the application by the FPC, the company said, would give it a total of 272,650 compressor hp of which 88,400 hp would be reciprocating and 184,250 hp would be centrifugal.

● **PIPE GAS FROM OFF-SHORE.** Continental Construction Company, Inc., has been awarded a contract by Lavaca Pipe Line Company, a wholly owned subsidiary of Aluminum Company, to lay the gas transmission line from four gas wells in Matagorda Bay to the site of Alcoa's reduction works at Point Comfort. The transmission line will be the largest gas transmission line ever laid to an off-shore gas field. It will be 11½ miles in length and 8⅝ in. in diameter.

● **IROQUOIS GAS PROPOSES N. Y. LINE.** Iroquois Gas Corporation of Buffalo, New York, plans a $1,357,000 expansion project. Included are construction of 13 miles of 22-in. diameter pipe line looping a section of the company's existing transmission lines, development of a new storage field, and enlargement of two existing ones. The company expects to complete work on the pipe line looping and on enlargement of the existing storage fields toward the end of the current year. Development of the new storage field is expected to be finished by the end of 1949.

● **UNITED NATURAL TO EXPAND.** United Natural Gas Company, Oil City, will construct facilities to enlarge its natural gas transportation and underground storage system in Pennsylvania.

The facilities, estimated to cost $3,057,500, include replacement of about 20½ miles of 12-in. pipe line in Elk County, Pennsylvania, with 22¾-in. pipe; construction of about 29 miles of 12¾-in. pipe line between a storage field and a compressor station in Elk County; about 4½ miles of 10 or 12-in. pipe line from a proposed storage field to a compressor station in Jefferson County, Pennsylvania; several short connecting lines in Jefferson and Clarion Counties and installation of an aggregate of 1650 hp in existing compressor stations in Jefferson and Elk Counties.

● **PLANS ILLINOIS GAS LINE.** Egyptian Natural Gas Company Salem, Illinois, proposes to build a natural gas pipe line extending from near Norris City to the vicinity of Centralia and Salem, Illinois, at a cost of $1,000,000. The company plans to purchase up to 20,000,000 cu ft of natural gas daily from Texas Eastern Transmission Corporation for transmission through its pipe line system.

● **CALIFORNIA LINES TO EXPAND.** Southern California Gas Company and Southern Counties Gas Company applied to Federal Power Commission for authorization to increase the delivery capacity of the California segment of the Texas-California pipe line by 100,000,000 cu ft of gas a day. The line's present capacity is 305,000,000 cu ft a day.

The proposed increase in facilities includes over 100 miles of 30-in. pipe line and additional compressor capacity at the Blythe, California, compressor station. The application estimates that the new construction would cost over $10,000,000. The companies intend to begin construction in November, 1948, and to complete it in two stages, so that the capacity of the present line west of the connection with El Paso Natural Gas Company at the California-Arizona boundary will be increased to 405,000,000 cu ft by October, 1951. This is equivalent to the energy delivered daily by eight dams the size of Hoover Dam.

El Paso Natural Gas Company recently applied to FPC for permission to supply the extra 100,000,000 ft of gas to the two California companies as well as an additional 80,000,000 cu ft to the Arizona-New Mexico area. The El Paso Company estimates cost of its project will run over $54,000,000.

● **FIRST MAINE PRODUCTS LINE.** Construction has begun on a 124-mile pipe line of the Socony-Vacuum Oil Company, Inc., from Portland to Bangor, Maine. About 50 men are employed in trench-digging and in pipe-laying.

This is the first petroleum finished products pipe line in Maine. It will be 6 in. in diameter, carrying gasoline and heating fuel to communities in the Portland and Bangor areas. Storage terminals are situated at Auburn-Lewiston, Hallowell, and Bangor. An existing pipe line carries crude oil from Portland to Montreal, Canada.

Completion of the new pipe line is scheduled for December. Socony-Vacuum officials said the line will assure more regular supplies of gasoline and heating fuel.

● **SOUTHERN AUTHORIZED TO ENLARGE SYSTEM.** Southern Natural Gas Company, Birmingham, Alabama, will construct facilities to increase its main line delivery capacity by approximately 35,000,000 cu ft daily to a total of 420,000,000 cu ft at an estimated cost of $3,531,000. The company operates in Alabama, Georgia, Louisiana, and Mississippi.

Facilities included in the authorization are 10,000 hp in 10 units at 2 main line compressor stations; about 6½ miles of 24-in. main line loops and a 4-line crossing of the Tallapoosa River; a new compressor station with 5000 hp installed capacity to be located between the Gwinville gas field and the present Pickens, Mississippi, compressor station; 5 miles of 8⅝ in. branch line looping and additional facilities for the dehydration of gas in the Gwinville Field.

● **FPC HEARINGS.** Hearings are in session in Washington before the Federal Power Commission on these applications:

Atlantic Seaboard and Virginia Gas Transmission Corporation have proposed joint construction and operation of 268 miles of 26-in. line from Clendenin, West Virginia, to Rockville, Maryland. Cost of the line and appurtenant facilities has been estimated at $20,649,600.

Commonwealth Natural's application requests authorization for construction and operation of a 537-mile of 20-in. pipe line from Tennessee Gas Transmission Company's trunkline at West Bend, Kentucky, to Norfolk, Virginia. Laterals would be constructed to Roanoke, Petersburg, Richmond, and Suffolk, Virginia. Cost has been estimated at $29,522,100.

Tennessee Gas Transmission Company wants to construct new facilities to increase its natural gas pipe line system to one billion cubic feet daily. Facilities proposed in the application, as amended, include about 909 miles of loops along the existing main pipe line; approximately 395 miles of 26-in. main line from northeastern Kentucky through Ohio and western Pennsylvania to the vicinity of Buffalo, New York; compressor units aggregating 91,200 hp, and various other equipment. Cost has been estimated at $118,396,000.

● **SOUTHERN LINE APPROVED.** Alabama-Tennessee Natural Gas Company has received FPC permission to construct facilities to serve northern Alabama and Mississippi markets. They include a 10¾-in. transmission line from a point of take-off from the line of Tennessee Gas Transmission Company near Selmer, Tennessee, to Tuscumbia, Alabama, a distance of about 75 miles. Cost of project is estimated at $2,900,000.

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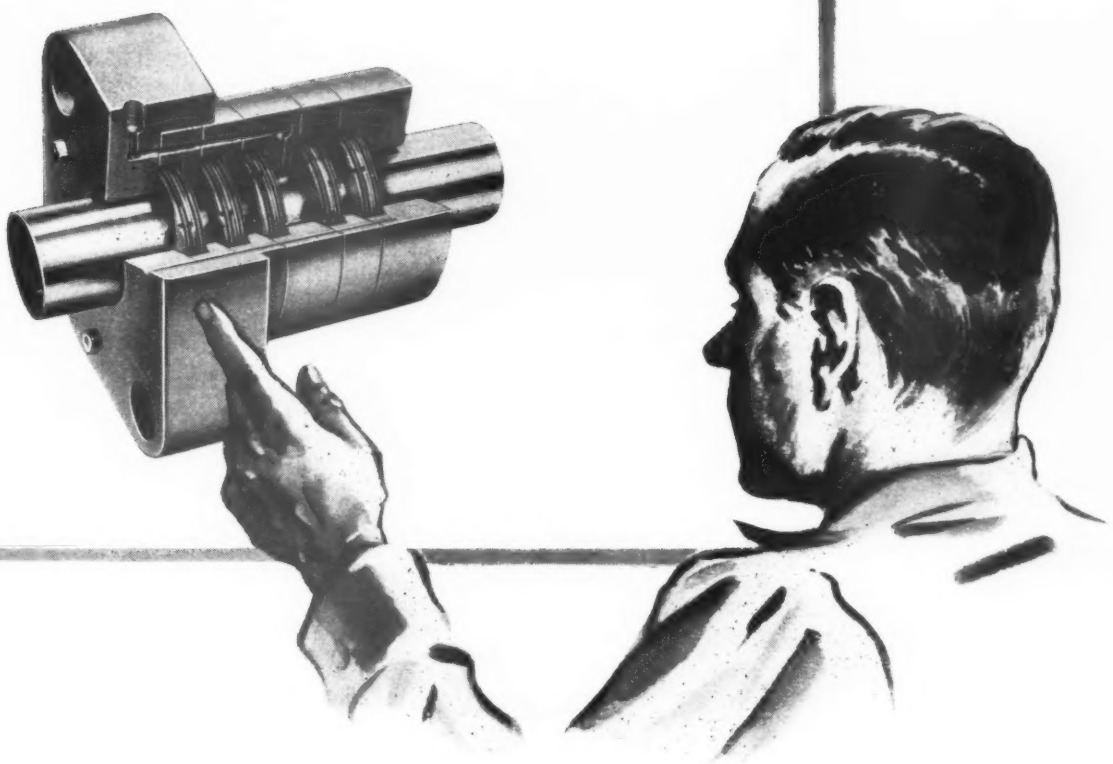

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● **SHELL CHEMICAL COMPLETES NEW PLANT.** Shell Chemical Corporation announced that another unit in its $43,000,000 expansion program has been completed and a new plant at Houston, Texas, is now in full operation producing two important synthetic chemicals, secondary butyl alcohol and methyl ethyl ketone.

Other plants in the expansion program, either already completed or scheduled to be completed later this year, will produce ethyl chloride, ethyl alcohol, glycerine and hexylene glycol (2-methyl-2, 4-pentanediol). Most of the increase in facilities is taking place in the Houston, Texas, area where Shell Chemical has been producing synthetic chemicals from petroleum since 1941.

The new installation represents an investment of $3,000,000 and will increase the company's facilities for marketing these chemicals by 150 per cent. Other Shell plants producing these products are at Martinez, California, near San Francisco, and at Dominguez, California, near Los Angeles.

● **TO EXPAND CHEMICAL PLANT.** The Frontier Chemical Company of Midland, Texas, is enlarging its electro-chemical manufacturing plant at Denver City, in Southwest Yoakum County. The concern is spending approximately $400,000 in the expansion program.

The plant, which produces hydrochloric acid, used in treating oil and gas wells, and caustic soda, for refineries, and as an ingredient in some varieties of oil well drilling fluids, will have the new units in operation by December 1, Robert L. Wood, Frontier president, said.

When the additions are completed the plant will be able to produce approximately 2000 tons of hydrochloric acid and about 600 tons of caustic soda, each month. That will be almost double the present output of the plant. Frontier is also putting in a solidifying and flaking unit for the caustic soda, at the Denver City plant.

● **TIDE WATER PLANS TCC UNIT.** Brigadier General David N. Hauseman, president of Houdry Process Corporation, disclosed that Tide Water Associated Oil Company will install a thermofor catalytic cracking (TCC) unit at its Drumright, Oklahoma, refinery. Signing of contracts with Houdry, as licensor and with Process Engineers, Inc., Dallas, as contractors, was announced by E. H. Salrin, vice president of Tide Water's Mid-Continent Division.

The TCC unit is designed to charge 4500 bbl a day with additional capacity up to 6750 bbl a day for recycling. One of the cat cracker's important design features is its ability to handle either Oklahoma or high sulphur West Texas gas oils.

● **SOCONY TPC UNITS.** The Rust Engineering Company of Pittsburgh, Pennsylvania, has been authorized by Socony-Vacuum Oil Co., Inc., to act as engineer-constructor for units to produce ethylene and aromatics by Socony's thermofor pyrolytic cracking process.

An adaptation of the widely used TCC catalytic cracking technique, Socony's new TPC process employs a moving bed of non-catalytic refractory particles as a heat transfer medium in direct contact with the oil to be cracked. Elimination of the coking difficulties encountered in conventional tube cracking permits operating the TPC process with low grade oils.

● **TIDE WATER UNIT HAS RECORD RUN.** The fluid catalytic cracking plant of Tide Water Associated Oil Company at Avon, California, completed its record-breaking run of 610½ days in continuous operation June 12, 1948, when it was shut down as planned for scheduled maintenance and repairs. This new record is 48 days more than the previous longest run of 562 days established by Cities Service fluid unit at Lake Charles, Louisiana.

Since October 11, 1946, when the run was started, about 11,000,000 bbl of fresh feed as heavy waxy distillate of about 23 API gravity were charged to the unit at an average daily charge rate of approximately 18,000 bbl. Liquid recovery in amount of 10,550,000 bbl was obtained from this 11,000,000 bbl of exceedingly low gravity vacuum flashed fresh feed charge, including 4,720,000 bbl of high octane catalytic gasoline and alkylation plant charge stocks. In addition, dry gas was produced and steam generated during this operation.

This is the third turnaround of the Avon fluid unit, which was designed by Universal Oil Products Company, erected in 1944 by C. F. Braun and Company, and initially placed on stream December 29, 1944. Through constant improvements made in operating technique, it has been possible to increase the on-stream time of each succeeding run, the initial run being 145 days, the next 415.8 days, followed by this recent record run of 610.5 days' continuous operation. During the 3½ years that this fluid unit has been in operation, over 21,000,000 bbl of heavy waxy vacuum flashed distillates have been converted into high octane motor gasoline fractions and other products.

● **"CAT" UNIT INSTALLED AT SUGAR CREEK.** Sixteen stories high, the new big fluid catalytic cracking unit for manufacturing petroleum products at the Sugar Creek, Missouri, refinery of Standard Oil Company (Indiana) was opened to a party of civic leaders and representatives of the press and radio. The new Sugar Creek unit processes 35,000 bbl of crude oil a day.

A. W. Peake, president of Standard of Indiana, and four other directors joined R. E. Beard, manager of the Sugar Creek refinery, and J. W. Wilson, manager of Standard's Kansas City sales field, as hosts for the tour of the big "cat."

Construction of the Sugar Creek cat cracker was started in January, 1946. The unit was completed early this July and has been in operation since.

Two elevators are installed in the big "cat." One is a high-speed passenger elevator for use of the operators in reaching the various levels to make adjustments to control the operation of the unit. The other elevator is a larger slow speed lift for use of mechanical crafts in transporting materials.

The fractionating tower on the new unit represents one of the largest shop-fabricated vessels ever shipped to a refinery. Measuring 108 ft long and 16 ft 2 in. in diameter and weighing 155 tons, the tower was transported more than 1600 miles via inland waterways.* It was delivered at the Sugar Creek refinery on the Missouri river 35 days after leaving Jersey City, New Jersey.

*See *The Petroleum Engineer*, March, 1947, Page 51, "Big Tower Towed From Jersey to Missouri."

Standard (Indiana) fluid catalytic cracking unit at Sugar Creek, Missouri.

THE Petroleum Engineer
AUGUST, 1948

Thermofor pyrolytic cracking process

By S. C. EASTWOOD and A. E. POTAS, Socony-Vacuum Oil Company, Inc.

THE postwar expansion of the chemical industry has created an unprecedented demand for ethylene and certain monocyclic and dicyclic aromatics. These chemicals are used in the manufacture of plastics, synthetic rubbers, insecticides, and many other organic chemicals.

Ethylene is obtained predominantly by recovery from refinery cracked gas streams and by pyrolysis of propane and ethane. It is also produced to a limited extent by pyrolysis of liquid stocks, such as crude oils, in localities where light hydrocarbons are not readily available. In most parts of the country the price of propane is increasing to the point at which it cannot be cracked profitably to produce ethylene. Thus ethane and liquid feed stocks appear to be the chief source of charge stocks for future cracking installations.

Aromatics are obtained in about equal quantities from the coal tar and petroleum industries.[1] Coal tar aromatics are by-products of coke oven operations and are, therefore, limited by the extent of these operations. The aromatics from petroleum are obtained by super fractionation and azeotropic distillation of select straight run, cracked, or hydroformed petroleum fractions.

The cracking of ethane or liquid feedstocks to produce high yields of ethylene requires extremely high temperatures, low pressures, and short contact times. Several methods have been employed in the past to carry out this type of cracking; i.e., the use of tubular, regenerative, or molten lead furnaces, and highly superheated steam. None of these methods, however, presents a satisfactory so-

TABLE 1. TPC cracking of light hydrocarbons for ethylene production.

Type of operation	Once through cracking			Recycle cracking	
Charge stock	Ethane		Propane	Mixed light hydrocarbons	
Composition, per cent wt				Fresh feed	Recycle
Methane + hydrogen	..		..	0.8	..
Ethane	99+		..	40.8	63.4
Propane	..		99+	40.0	14.4
Propylene	..		..	16.0	22.2
C_4's	..		..	2.4	..
Total	..		..	100.0	100.0
Pebble preheat temperature, F	1525	1770	1510	1500	
Contact time, sec	2.3	0.12	1.2	1.7	
Recycle to fresh feed ratio, wt	..	..	..	1.0	
Yields, per cent wt on charge					
Hydrogen	5.7	5.7	2.0	3.2	
Methane	12.8	10.2	26.2	23.2	
Acetylene	0.7	3.8	0	0	
Ethylene	49.2	56.2	37.5	62.0	
Ethane	18.2	11.6	3.5	..	
Propylene	0.7	1.0	12.2	..	
Propane	1.1	0.7	7.9	..	
Butadiene	1.6	3.2	2.3	0	
Butylenes	1.8	0.4	1.1	3.0	
Butanes	1.0	0.3	0	2.0	
C_5+	6.7	6.1	6.8	5.0	
Coke	0.5	0.8	0.5	1.6	
Total	100.0	100.0	100.0	100.0	
Ethylene concentration in C_2 and lighter, mol per cent	29.0	33.3	32.7	30.1	

lution to the main processing problems inherent in this type of cracking; namely, efficient transfer of heat from the primary source to the material being cracked, rapid heating to high temperatures, freedom from fouling with coke, and simplicity of operation. To meet these problems a new process called Thermofor Pyrolytic Cracking has been developed in the Socony-Vacuum Laboratories at Paulsboro, New Jersey.

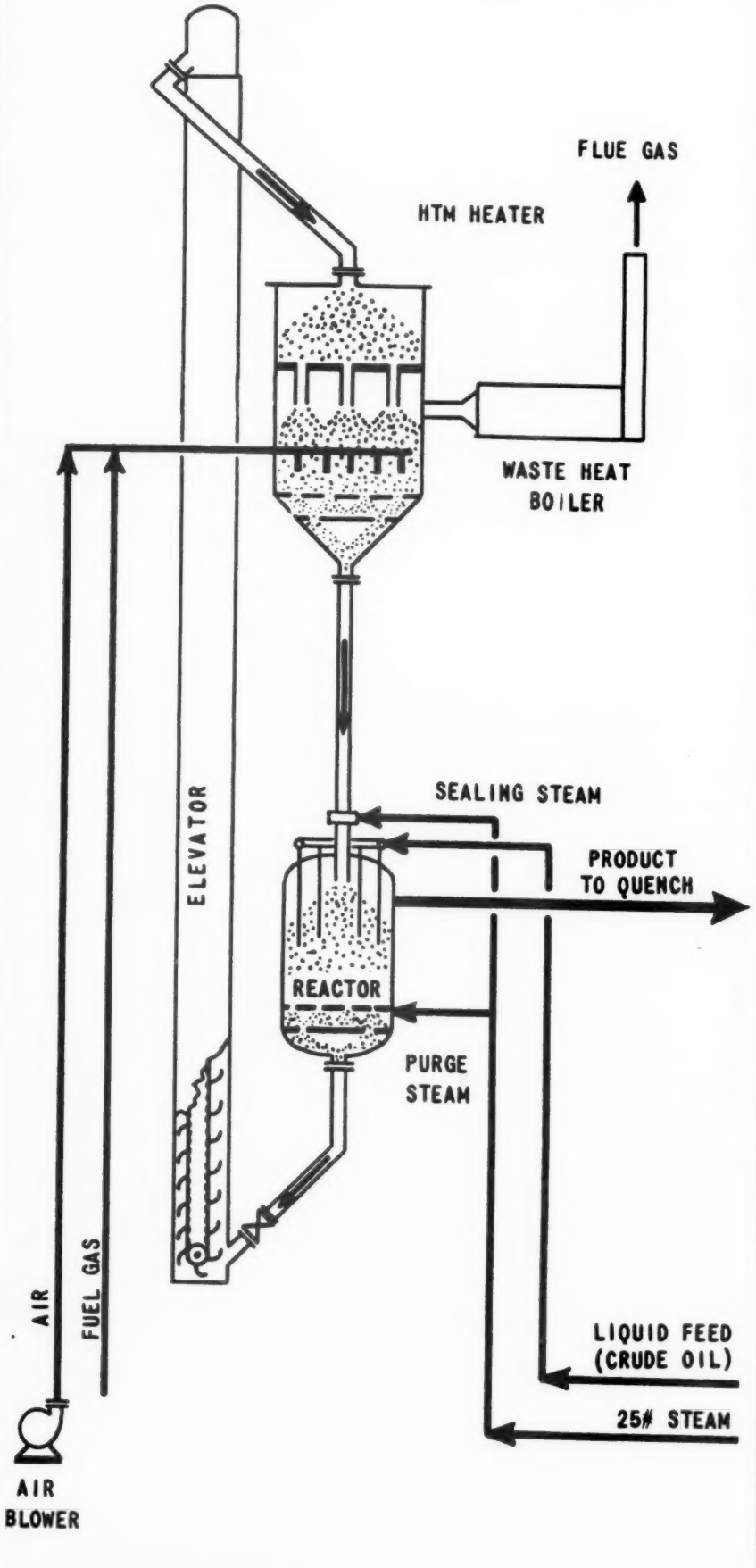
● **The TPC process.** The TPC process is based on techniques and knowledge acquired in the development of the TCC process[2] and is similar to TCC in that hydrocarbon feed is contacted continuously with a moving bed of solids. The new process is covered by patents assigned to Socony-Vacuum Oil Company.

The TPC system comprises two main elements: A reactor and a heater. A bucket elevator is used to lift the pebbles to the top of the unit where they are discharged into the heater. The heater serves to preheat the pebbles to the desired temperature level by direct combustion of fuel gas in the pebble bed. Any coke deposited on the pebbles in the cracking step is burned off in this stage. The hot pebbles flow by gravity from the heater into the reactor where the heat stored in the pebbles is utilized to preheat and crack the hydrocarbon feed. The cooled pebbles from the reactor flow through a throttling valve and into the elevator, which returns them to the top of the unit for reuse. A specially designed baffle system is used to prevent channeling of the pebble flow in both the reactor and heater. A diagrammatic sketch of the TPC system is Fig. 1.

Pebbles satisfactory for use in this process are non-catalytic refractory materials of spherical shape 0.2 to 0.4 in. in diam meeting the following requirements: (1) High density—for compact unit design, (2) high specific heat—to reduce the weight that must be circulated, (3) high resistance to wear, spalling, and breaking—to minimize replacement rate, (4) low abrasion characteristics—to prevent excessive wear on vessels, and (5) high softening temperatures. Several materials developed by refractory companies appear to meet all the above requirements. This development work has involved extensive testing in Socony-Vacuum pilot plant equipment designed to simulate the most rigorous conditions likely to be found in commercial TPC plants.

One of the problems encountered in the development of the TPC process was to find an efficient means of preheating the pebbles. This led to the development of a heater employing direct combustion of air and gas in the pebble bed. A pilot plant heater representing a full scale section of a proposed commercial heater has been operated for several years.[3] This heater is capable of heating about two tons per hour of pebbles from 1000 to 1600 F. It was found that by proper adjustment of all the variables involved, burning efficiencies approaching theoretical can be obtained with 0 to 5 per cent excess air and with complete combustion to carbon dioxide and water. Externally fired heaters can be used but

FIG. 1. TPC UNIT FOR ETHYLENE AND AROMATICS PRODUCTION.



are more expensive and less efficient.

The flow of hydrocarbons relative to pebbles through the reactor is countercurrent. The charge stock may be partially heated outside the reactor or may be introduced cold directly into the lower section of the reactor, where residual heat is available in the pebbles for preheating or vaporizing the feed. Extremely high rates for heat transfer, in the order of 15,000 Btu per hr per °F per cu ft of pebbles, are obtained in this type of reactor. Thus the charge stock is preheated to high temperatures very rapidly and undesirable cracking at low temperatures is minimized. The cracking temperature is controlled by the temperature of the pebbles entering the reactor and by the ratio of pebble circulation rate to hydrocarbon charge rate. The hydrocarbon contact time is controlled by the vapor rate through the reactor and the bed depth. The cracked vapors leaving the reactor are quenched immediately to prevent decomposition or polymerization of the ethylene.

The TPC process has the advantage of being extremely flexible with respect to the type of charge stock processed. It can be designed to crack either gaseous or liquid feedstocks. Crude oils or reduced crudes can be handled just as easily as distillate stocks because any carbon formed on the pebbles during cracking is continuously removed from the reactor. Carbon deposited in this manner is an advantage with the TPC process because it lowers the external fuel requirements in the heating stage.

● **Pilot plant studies.** TPC cracking studies have been made in a per-day pilot unit capable of operating at temperatures up to 1800 F. Charge stocks ranging from ethane to reduced crudes have been evaluated for ethylene and aromatics production. The preferred operating conditions for ethylene production vary with the charge stock but generally fall within the following range:

Pebble to hydrocarbon feed ratio, wt	10-20
Pebble preheat temperature, F	1400-1800
Hydrocarbon contact time, sec	0.1-2.5
Pressure, psig	0-5
Steam, per cent wt of charge	0-50

Of the various charge stocks evaluated, ethane gives the highest yield, propane next highest, whereas the lowest yields are obtained from aromatic and naphthenic type liquid charge stocks.

TABLE 2. TPC cracking of liquid feed stocks for ethylene production.

Charge stock	Michigan crude	East Texas crude	Slaughter-Duggan crude	Mirando crude	Naphthenic catalytic light cycle stock
Properties					
Gravity, API	34.8	38.4	31.0	21.2	26.6
Aniline point, F	160	172	143	131	114
Sulphur, per cent wt	0.39	0.33	2.30	0.24	0.28
Distillation, F					
I.B.P.	223	148	150	240	412
10 per cent volume	328	290	252	448	459
50 per cent volume	572	595	585	620	510
90 per cent volume	993	980 at 80%	902 at 75%	915	600
Pebble preheat temp., F	1550	1515	1500	1500	1515
Yields, per cent wt on charge*					
Hydrogen	0.9	0.7	0.7	0.7	0.6
Methane	14.8	14.1	15.3	13.0	10.8
Ethylene	28.8	22.3	17.9	12.5	11.7
Ethane	3.5	4.3	4.5	3.0	2.3
Total C_2+lighter	48.0	41.4	38.4	29.2	25.4
Propylene	6.4	12.2	8.0	6.8	6.5
Propane	0.7	0.7	0.6	0.6	1.0
Butadiene	2.5	3.1	1.0	1.6	1.0
Butylenes	1.4	3.0	1.7	2.9	3.0
Butanes	0.9	0.6	1.2	0.2	2.7
Total C_5's	1.0	0.7	1.4	1.8	3.6
Total C_2's to C_5's	12.9	20.3	13.9	13.9	17.8
C_6 to 500 F liquid				29.6	24.7
500 F+liquid	36.4	36.5	44.1	25.6	30.5
Coke	2.7	1.8	3.6	1.7	1.6
Total	100.0	100.0	100.0	100.0	100.0
Ethylene concentration in C_2 & lighter, mol per cent	40.9	36.7	30.5	26.1	28.4

*The light hydrocarbon distribution does not include H_2S. In the above operations on sweet stocks the H_2S produced is small (0.1 per cent wt on charge); however, on the Slaughter-Duggan crude, the H_2S is estimated to be 1.0 per cent wt of charge.

● **Ethylene yields from C_2 and C_3 gases.** Typical ethylene yields for TPC cracking of ethane, propane and ethane-propane-propylene mixtures are shown

REAR STEP GUARDS

The light truck used to handle meters to the field by one gas company was frequently damaged by being driven under the overhang of the service department platform. To protect the truck body, ears or "horns" were welded to the bumper at the ends, to abut against the edge timber of the platform when the truck was backed up to load.

The horns also served as safety measure. They prevented the service man's foot from slipping past the point where he could safely lift the meters as he placed them in the truck.

The additions to the bumper were made from 2½-inch channel, and were beveled at the top for sake of appearance. They were made short enough so that the truck doors could open wide without striking them.

The top surface of the bumper was roughened by welding ridges along it, to reduce further danger of skid or slip.

in Table 1. Once-through cracking of ethane with a pebble temperature of 1525 F and a contact time of 2.3 sec gives an ethylene yield of 49.2 per cent wt. Recycling the unconverted ethane would give an ultimate ethylene yield of 60.1 at a recycle ratio of 0.22 parts recycle to 1.00 part fresh feed. Increasing the cracking temperature and decreasing contact time raises the once-through ethylene yield. For example, at a 1770 F pebble temperature and 0.12 sec contact time, the once-through ethylene yield is increased to 56.2 per cent wt. At this temperature the yield of acetylene becomes appreciable, being 3.8 per cent wt of charge. An ultimate ethylene yield of 63.6 per cent wt would be obtained at a recycle ratio of 0.13 parts recycle to 1.00 part fresh feed.

Once-through cracking of propane with a pebble temperature of 1510 F and a contact time of 1.2 sec gives an ethylene yield of 37.5 per cent wt. About the same conversion of propane and ethane are obtained at 1510-1525 F for the operations described but ethane requires double the contact time as compared to propane.

Several C_3-C_5 gas mixtures, typical of feedstocks that can be recovered from refinery cracked gas streams, have been evaluated. An ultimate ethylene yield of 62.0 per cent wt was obtained from a mixture comprising 40.8 per cent wt ethane, 40.0 per cent wt propane, and 16.0 per cent wt propylene at a pebble temperature of 1500 F, a contact time of 1.7 sec, and a recycle ratio of 1.00 part recycle to 1.00 part fresh feed.

● **Ethylene yields from liquid charge stocks.** Typical ethylene yields for TPC cracking of several liquid charge stocks are shown in Table 2. The ethylene yields range from 28 per cent wt of charge from the most paraffinic stock to 11.7 per cent wt from the most naphthenic stock. As in the case of ethane, the ethylene yield can be increased from these stocks to a certain degree by increasing the pebble temperature and decreasing contact time.

The yields of other olefins, such as propylene, butylenes, and butadiene, can be increased by decreasing the cracking temperature or contact time. Adjusting the operating conditions to increase the yields of these higher molecular weight olefins, however, generally results in a loss in ethylene yield.

● **Simultaneous production ethylene and aromatics.** The TPC cracking of liquid charge stocks to produce ethylene gives a fraction boiling between 150 and 500 F containing 40 to 75 per cent wt aromatics. The concentration of aromatics in this liquid fraction can be increased to 90-95 per cent by increasing the contact time of the cracking reaction several fold. Although increasing the contact time through this range does not change the ethylene yield appreciably it does decrease the ethylene concentration in the C_2 and lighter gas, making the recovery of ethylene more costly. This, however, is not a serious factor where both ethylene and aromatics are desired. Typical aromatic yields from several charge stocks are shown in Table 3. It will be noted that aromatic and naphthenic stocks give the highest yield of aromatics and that the ratio of monocyclic to dicyclic aromatics can be controlled to a considerable extent by choice in boiling range of the charge stock. As the chief impurities in the aromatic fraction are olefins, high purity aromatics can be prepared by acid treating to remove olefins, neutralizing, washing, and distilling.

TABLE 3. Aromatic distribution obtained by TPC cracking of liquid feed stocks.

Charge stock	Mirando crude	East Texas crude	Naphthenic catalytic light cycle stock	Paraffinic catalytic light cycle stock	Virgin coastal naphtha
Aromatic yields, per cent wt					
Benzene	7.7	7.8	5.9	5.9	12.4
Toluene	5.8	3.6	3.7	3.2	8.2
Xylenes	1.9	1.2	0.9	0.9	2.3
Styrene	0.1	0.2	0.2	0.1	0.3
Other C_8 aromatics	0.6	0.5	0.5	0.3	0.3
C_9+C_{10} aromatics	1.2	1.0	0.8	0.5	1.4
Naphthalene	3.9	2.2	3.4	4.3	3.2
1-Methyl naphthalene	2.1	1.0	2.6	3.7	1.1
2-Methyl naphthalene	1.5	0.8	1.2	1.5	0.7
Total	24.8	18.3	19.2	20.4	29.9
Liquid boiling above 2-methyl naphthalene	28.4	20.0	31.8	33.5	15.9
Aromatic concentration in C_6 to 2-Me-Naph. fraction, per cent volume	94.0	90.5	93.0	95.8	90.2
Ratio mono-cyclic to di-cyclic aromatics	2.30	3.57	1.67	1.14	4.98
Ethylene, per cent wt	12.5	21.6	15.7	16.6	15.0
Total aromatics + ethylene, per cent wt	37.3	39.9	34.9	37.0	44.9
Ethylene concentration in C_2+lighter, mol per cent	21.7	31.9	24.4	29.0	21.7

TABLE 4. Principal products for a typical commercial TPC project. (100 per cent recovery basis)

Charge stock	2400 bbl per day East Texas crude
Products:	
Ethylene, lb per year	50,000,000
Propylene, lb per year	20,300,000
Butadiene, lb per year	3,200,000
Benzene, gal per year	2,440,000
Toluene, gal per year	1,130,000
Xylenes, gal per year	400,000
C_8—C_{10} aromatics, gal per year	530,000
Naphthalene, lb per year	5,100,000
Methyl-naphthalenes, lb per year	4,200,000
Higher boiling liquid, gal per year	4,720,000

An appreciable yield of material boiling above 500 F is also produced from TPC cracking of liquid feedstocks. This material has not been completely analyzed but undoubtedly is rich in high boiling polynuclear aromatics that might be valuable.

● **Scale of proposed commercial operation.** Several chemical companies are actively considering the installation of TPC facilities to manufacture ethylene and aromatics. One of the projects involves the cracking of 2400 bbl per day of East Texas crude to produce 50,000,000 lb per year of ethylene. The quantities of other major chemical products from such an operation are in Table 4.

● **Summary.** A new process, Thermofor Pyrolytic Cracking, has been developed for high temperature, low pressure cracking to produce ethylene and aromatics. It has the following features:

1. Wide flexibility with respect to charge stock.
2. Efficient transfer of heat from the primary source to the hydrocarbon being cracked.
3. Rapid heating of the hydrocarbon charge to high cracking temperatures.
4. Continuous elimination of any coke formed in the reactor during cracking.
5. Ability to introduce charge stock into the reactor without preheat.

The TPC process is licensed from Socony-Vacuum through contractors such as Vulcan Copper and Supply Company and Rust Engineering Company.

● **References**

(1) *Synthetic Organic Chemicals United States Production and Sales.* United States Tariff Commission Yearly Reports.
(2) "The Thermofor Catalytic Cracking Process," by T. P. Simpson, L. P. Evans, C. V. Hornberg, and J. W. Payne. *API Proceedings 23* (3) 59, 1942.

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Hydrocarbon absorption and fractionation process design methods

Part 15. Short Cut and Empirical Equilibrium Plate Calculation Methods

By WAYNE C. EDMISTER*

EXCLUSIVE

Because of the complexity of multicomponent fractionation calculations, many short cut and empirical methods have been suggested for making the theoretical plate calculations to find the reflux ratio and number of equilibrium stages required for a given separation. Two of these methods employ the minimum reflux and minimum plates limits directly in the calculations. In making any approximation it is well to establish these limits. In a rigorous plate-to-plate design, such as those discussed and illustrated in Part 13, the minimum reflux and plates limits are not quite as important.

Most of these short cut and empirical methods are satisfactory for sharp separations between adjacent components where there are no intermediate distributed components. In such cases the calculations are primarily concerned with the two key components, the lighter and heavier non-distributed components entering into the determination of the equilibrium and material balance relationships.

GILLILAND SHORT CUT RELATIVE VOLATILITY AND RELATIVE OPERABILITY METHOD

This method, which was published in 1935[6], employs a term called relative operability and given the symbol β, as well as the relative volatility, α. The method is a rapid approximation that can be used with a fair degree of accuracy for sharp separations.

The equations for this method are derived for each section of the fractionator by:

(a) Writing the equilibrium relationship for the two key components in terms of the relative volatility:

(b) writing the component material balances for the composition change of the two keys across any one equilibrium stage;

(c) Dividing the component material balance equation for the light key by the corresponding equation for the heavy key;

(d) Defining the portion of this material balance ratio equation that locates the operating lines as the relative operability, β;

(e) Combining the relations from (a) and (d) to give an equation for the relative changes in composition for one complete equilibrium stage, i.e. from the liquid on one to the liquid on the next; and

(f) Expanding the resulting relationships for the total plates in each section, thus obtaining equations for the relative composition changes across both enriching and stripping sections.

These equation development steps are straight forward and need not be included here. The resulting equations are given in Table 69, which is a summary of this method. It will be noted that feed plate compositions are required for the solution of the equations. These feed plate compositions can be estimated in the manner illustrated in Table 57. If the mixture is mostly key components with small amounts of lighter and heavier non-distributed components, the feed plate composition may be approximated by using the feed composition.

The exponential equation given in Table 69 is shown as applying to each section separately with the products and feed plate as the terminals. This same equation may be applied for the entire fractionator at once and thus minimize errors due to uncertainties in the feed plate composition. Also the liquid compositions on the top and bottom plates may be used rather than those of the distillate and bottoms and also improve accuracy. In this method of application it is not necessary to estimate the feed plate composition, yet this is worth while to help establish the (α/β) ratio for the solution.

Example 35. As an illustration of the Gilliland short-cut method, summarized in Table 69, the number of theoretical plates required for the problem used in the previous examples will be computed.

For this calculation the data in Tables 55 and 57 will be used as the starting basis. For convenience this starting data will be included in the following tabulation:

	Enriching		Stripping	
	Top plate	Plate n	Plate m	Bottom plate
C_3 mole fract.....	0.85	0.434	0.510	0.022
C_4 mole fract.....	0.069	0.400	0.281	0.540
$\alpha = K_3/K_4$.....	2.54	2.11	1.94	1.85

The equations given in Table 69 indicate the terminals of each section as *distillate, feed plate, feed plate* and *bottoms*. It is better to use the terminal plates of each section where possible and this will be done here.

The values of L are 90 and 124, for the enriching and stripping sections, respectively. The distillate, D=59.9 and the bottoms, B=40.1. From these compositions and quantities, the relative operabilities will be calculated for each section.

For the top of the enriching section:

TABLE 69

SUMMARY OF GILLILAND SHORT-CUT METHOD

This method is based on "relative volatility" and "relative operability."

Fractionation equation:

$$\left(\frac{X_{\text{light key}}}{X_{\text{heavy key}}}\right)_{\substack{\text{distillate or}\\ \text{(feed plate)}}} = \left(\frac{\alpha}{\beta}\right)^{\substack{\text{m (or m)}\\ \text{average}}} \left(\frac{X_{\text{light key}}}{X_{\text{heavy key}}}\right)_{\substack{\text{feed plate or}\\ \text{(bottoms)}}}$$

Relative volatility:

$$\alpha = \frac{K_{\text{light key}}}{K_{\text{heavy key}}}$$

α is usually evaluated at the terminal plates of both enriching and stripping sections for the keys.

Relative operability:

Enriching

$$\beta = \frac{1+\left(\frac{D}{L}\right)\left(\frac{X_d}{X_i}\right)_{\text{light key}}}{1+\left(\frac{D}{L}\right)\left(\frac{X_d}{X_i}\right)_{\text{heavy key}}}$$

Stripping

$$\beta = \frac{1-\left(\frac{B}{L}\right)\left(\frac{X_b}{X_j}\right)_{\text{light key}}}{1-\left(\frac{B}{L}\right)\left(\frac{X_b}{X_j}\right)_{\text{heavy key}}}$$

β is usually evaluated at the terminal plates of both enriching and stripping sections, using compositions of keys in products and at the points in question.

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TABLE 70

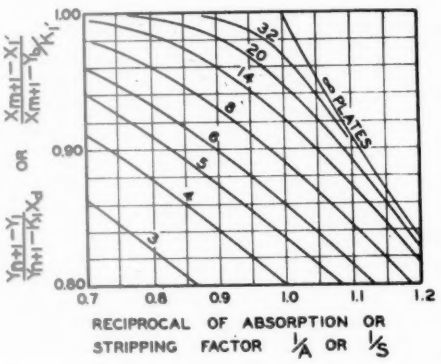
SUMMARY OF BROWN ET AL. ABSORPTION FACTOR METHOD

Shortcut method using average values of absorption and stripping factors.

Equations:

Enriching section $$\frac{Y_{n+1}-Y_1}{Y_{n+1}-K_1X_d}=\frac{A^{n+1}-A}{A^{n+1}-1} \quad \text{where } A=\frac{L}{KV}$$

Stripping section $$\frac{X_{m+1}-X_{1'}}{X_{m+1}-Y_b/K_{1'}}=\frac{S^{m+1}-S}{S^{m+1}-1} \quad \text{where } S=\frac{KV}{L}$$



Procedure:

1. Product distribution and reflux quantities.
2. Feed plate vapor and liquid compositions.
3. Terminal conditions for both sections.
4. Compute values of A&S for distributed components.
5. Using average values of A&S, find functions from graph for assumed plates.
6. Solve equations.
7. Combine results and balance components.

$$\beta=\frac{1+\left(\frac{59.9}{90.0}\right)\left(\frac{0.410}{0.85}\right)}{1+\left(\frac{59.9}{90.0}\right)\left(\frac{0.005}{0.069}\right)}=1.26$$

For plate n (bottom plate in enriching section):

$$\beta=\frac{1+\left(\frac{59.9}{90.0}\right)\left(\frac{0.410}{0.434}\right)}{1+\left(\frac{59.9}{90.0}\right)\left(\frac{0.005}{0.400}\right)}=1.60$$

For the bottom of the stripping section:

$$\beta=\frac{1-\left(\frac{40.1}{124}\right)\left(\frac{0.01}{0.022}\right)}{1-\left(\frac{40.1}{124}\right)\left(\frac{0.418}{0.540}\right)}=1.14$$

For plate m (top plate in stripping section):

$$\beta=\frac{1-\left(\frac{40.1}{124}\right)\left(\frac{0.01}{0.510}\right)}{1-\left(\frac{40.1}{124}\right)\left(\frac{0.418}{0.281}\right)}=1.92$$

For a column wherein β varies so widely it is frequently better to use over-all average α and β values and solve for the total number of plates in one step. For this calculation, the average α/β will be found from α and β values at all four points.

$$\left(\frac{\alpha}{\beta}\right)_{av}=\frac{2.54+2.11+1.94+1.85}{1.26+1.60+1.92+1.14}=1.42$$

Applying the fractionation equation:

$$\left(\frac{0.85}{0.069}\right)=(1.42)^{n+m}\left(\frac{0.022}{0.540}\right)$$

$n + m = 16$ total theoretical plates.

This is in good agreement with 15 theoretical plates found by the plate-to-plate calculations. Had the value of (α/β) for this calculation been obtained from the top and bottom conditions only, i.e., neglecting feed plate conditions, the result would be 9.5 plates instead of 16.

BROWN ABSORPTION FACTOR METHOD

In Part 5 (*The Petroleum Engineer*, September, 1947) the absorption-stripping factor approximation method of designing absorbers and strippers was discussed. In 1935 Brown et al[2] suggested a multicomponent fractionation design method employing these same equations. The equations derived in Part 5 are sufficient for the current purposes. Table 70 gives a summary of the fundamentals of this method.

In the proposed methods, the enriching section of the fractionator is treated as an absorber and the stripping section of the fractionator is treated as a stripper. In other words, the absorption calculations are made on the vapor going to the enriching section and stripping calculations are made on the liquid going to the stripping section. These calculations require compositions of the vapor to enriching section and of the liquid to the stripping section. In their paper, the authors suggested a method of estimating the feed plate composition that does not make proper allowances for the zones of constant composition.

However, the vapor and liquid compositions found in the preliminary steps given in Table 57 may be used.

In using the L/KV and KV/L factors, rather than functions of α, the choice of average factors for each section is more of a problem. The authors use arithmetic averages. The x_d and y_b are the mole fractions in the reflux and the reboiled vapor, respectively.

Example 36. As an illustration of the Brown et al absorption factor method, summarized in Table 70, the same problem used in previous examples will be solved. In this solution it will be most convenient to start with the desired product composition and the number of plates found by the plate-to-plate calculations and find, as a result of the calculations, the compositions of the vapor to enriching section and of the liquid to the stripping section. These compositions should check those found in Table 57 for a correct solution.

The L/KV and KV/L factors for the terminals of each section are:

	Enriching Section, $\frac{L}{V}=0.6$			
	Top plate		Plate n	
	K	L/KV	K	L/KV
C_3	0.76	0.79	1.170	0.513
C_4	0.30	2.00	0.553	1.09

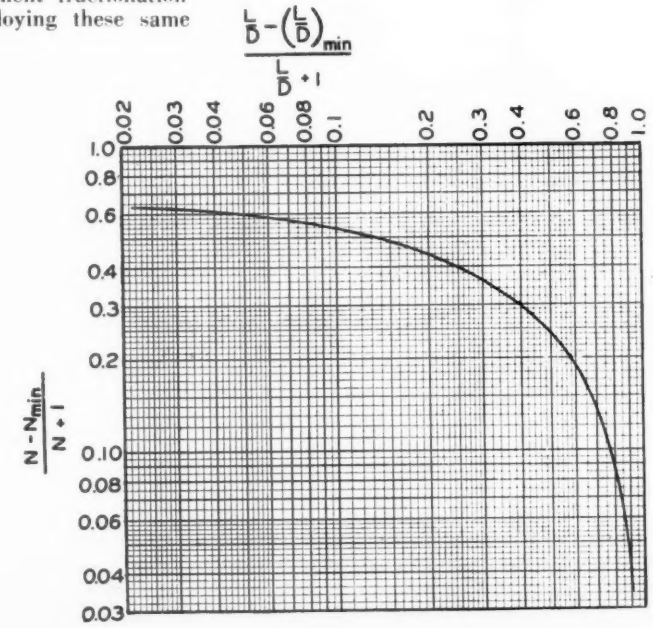


FIG. 56. Gilliland's plot relating reflux ratio with number of equilibrium stages and minimum values.

Redrawn from Industrial and Engineering Chemistry, Vol. 32, 1220, Sept., 1940.

TABLE 71

SUMMARY OF BROWN-MARTIN EMPIRICAL FRACTIONATION METHOD

With Colburn Minimum Reflux Method

This method employs an empirical correlation of minimum number of equilibrium plates (at total reflux), minimum reflux ratio (infinite plates), with the number of theoretical plates at an intermediate reflux ratio and is based on "key components" and "pinch points" concepts. Key components are those components appearing in both distillate and bottoms products. Pinch points are zones in both enriching and stripping secious where the key components have zero concentration gradients. Brown-Martin correlation was developed from separation calculations for many binary and multicomponent systems.

Feed plate cannot be located by this method. Minimum plates and minimum reflux represent limits between which all actual operating conditions for a given separation must fall.

Empirical Relationship

Above graph gives values of $\frac{J}{J_{min}}$ as a function of $N/N_{(r=1)}$

$$\frac{N}{N_{(r=1)}} = \frac{\text{Number of equilibrium plates at intermediate reflux}}{\text{Minimum number of equilibrium plates at total reflux}}$$

Both N and $N_{(r=1)}$ are for same separation.

$$\frac{J}{J_{min}} = \frac{\left[\left(\frac{L}{V}\right)_s \left(\frac{V}{L}\right)_e - 1\right]_{\text{intermediate reflux}}}{\left[\left(\frac{L}{V}\right)_s \left(\frac{V}{L}\right)_e - 1\right]_{\text{minimum reflux}}}$$

$\left(\frac{L}{V}\right)_s$ = average $\frac{L}{V}$ ratio for stripping section.

$\left(\frac{V}{L}\right)_e$ = average $\frac{V}{L}$ ratio for enriching section.

Procedure:

1. Make customary preliminary calculations for desired separation, finding top and bottom temperatures and also L and V quantities in both sections.
2. Find minimum number of plates at total reflux by equation.
3. Find minimum reflux ratio for desired split by method of Colburn shown here.
4. Determine number of theoretical plates required for desired separation with assumed intermediate reflux ratio.
5. Adjust original assumptions and repeat if necessary.

Minimum Plates:

With total reflux (infinite reflux ratio) the number of theoretical plates required for a given separation will be the minimum that can be used to obtain the desired separation. The following equation relates degree of separation and minimum number of plates.

$$\left(\frac{d_1}{d_j}\right)\left(\frac{b_j}{b_1}\right) = \left(\frac{K_1}{K_j}\right)^{\text{min. plates}}_{\text{average}}$$

The first term is the concentration ratio of the lightest to the heaviest key component in the distillate product.

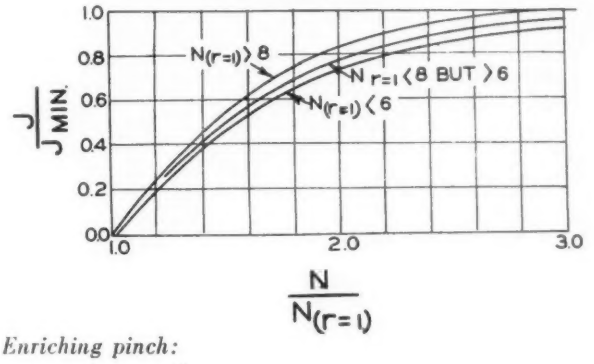
The second term is the concentration ratio of the heaviest to the lightest key component in the bottoms product.

The last term is the average relative volatility of the key components with the number of minimum plates as the exponent.

Minimum Reflux:

Finding the minimum reflux ratio for a given separation involves successive approximations, using the following equations and graph of Colburn. These equations are expressions for the pinch point concentrations. Since the sum of X values at each pinch must equal unity, trials must be made until these conditions are satisfied.

Brown-Martin empirical relationship between minimum and intermediate values of reflux ratio and number of theoretical plates.



Enriching pinch:

$$x_n = \frac{x_n}{K + (K-1)(L_n/D)}$$

Stripping pinch:

$$x_m = \frac{x_d}{K + (1-K)(L_m/B)}$$

x_n = concentration of a component (heavy key and lighter components) at the upper pinch zone.

x_d = concentration of corresponding component in distillate.

x_m = concentration of a component (light key and heavier components) at the lower pinch zone.

x_b = concentration of corresponding component in bottoms.

At minimum reflux ratio, the ratios of the pinch concentrations for the key components are related by the following equation, which is due to Colburn:

$$\frac{r_m}{r_n} = \psi = \frac{1}{(1 - \Sigma C_m \alpha x_m)(1 - \Sigma C_n x_n)}$$

r_m = ratio of light key to heavy key at stripping pinch.

r_n = ratio of light key to heavy key at enriching pinch.

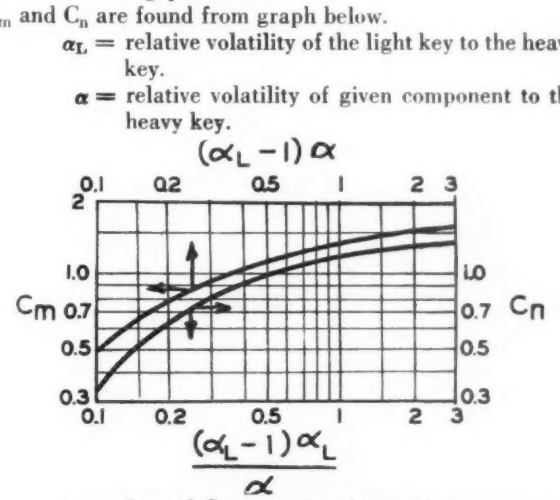
$\Sigma C_m \alpha x_m$ = summation of values of $C_m \alpha x$ for all components heavier than the heavy key at the stripper pinch.

$\Sigma C_n x_n$ = summation of values of $C_n x$ for all components lighter than the light key at the enriching pinch.

C_m and C_n are found from graph below.

α_L = relative volatility of the light key to the heavy key.

α = relative volatility of given component to the heavy key.



C_m and C_n correction factors for Colburn Minimum Reflux Ratio Method

	Stripping Section, $\frac{V}{L}$ = 0.667			
	Bottom plate		Plate m	
	K	KV/L	K	KV/L
C_3	2.40	1.60	1.58	1.06
C_4	1.30	0.870	0.80	0.535

The average factors for use in the calculations and the values of the A and S functions, from the equations or graph in Table 70 and with n=6 and m=9, are

	Average value of		$\left(\frac{A^7-A}{A^7-1}\right)$	$\left(\frac{S^{10}-S}{S^{10}-1}\right)$
	A	S		
C_3	0.651	1.33	0.631	0.923
C_4	1.545	0.702	0.972	0.700

With these values for the A and S functions, the composition change equations can be solved using the following compositions calculated from Table 55:

	Symbol	Mole fractions C_3	Mole fractions C_4
Reflux liquid	X_d	0.811	0.0310
Top vapor	Y_1	0.65	0.0206
Vapor to enriching	Y_{n+1}	0.425	0.241
Liquid to stripping	X_{m+1}	0.371	0.354
Bottom liquid	X_1	0.0218	0.542
Reboiled vapor	Y_b	0.0274	0.602

By substituting into the enriching and stripping equations the following values of feed plate compositions are obtained:

		C_3	C_4
Vapor to enriching	Y_{n+1}	0.705	0.410
Liquid to stripping	X_{m+1}	0.147	0.727

These values do not agree with the above data from Table 57, the differences indicating that the fractionation equations of this method predict less efficient separation than can be obtained via plate-to-plate calculations. The high concentrations of C_3 in vapor to reboiling and of C_4 in liquid to stripper prompt this conclusion.

BROWN-MARTIN EMPIRICAL METHOD

In 1939 Brown and Martin[3] proposed an empirical method for obtaining the number of equilibrium plates required for a given separation at a reflux ratio intermediate between the minimum and infinite. This method, which is summarized in Table 71, is based upon an empirical correlation of a reflux ratio function (minimum and intermediate) with the ratio of actual to minimum plates.

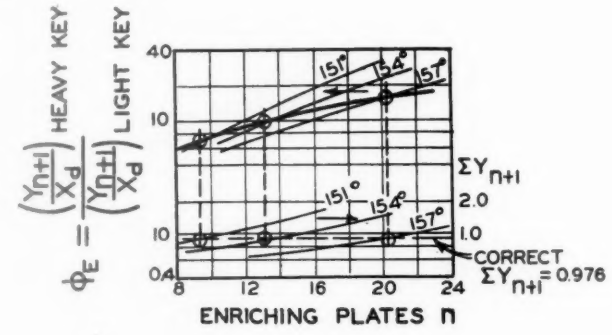
This empirical correlation was developed from the results of rigorous calculations for a large number of separations, most of which were binary systems but some were complex multicomponent systems. The authors found that an empirical correlation of this kind developed for binary systems, also applied to multicomponent systems.

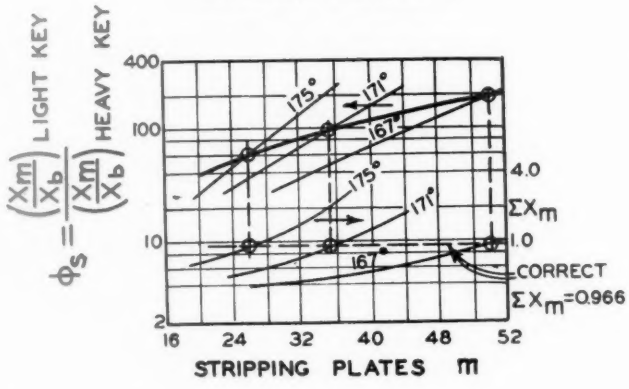
The application of this method require first estimating the minimum number of plates required for total reflux and the minimum reflux ratio required with infinite plates. Then it is a simple matter to find from these two limits the number of plates required at any inter-

TABLE 72

SUMMARY OF R. L. SMITH METHOD

Based on: Using average temperatures for each section. Solving equations for several assumed temperatures and number of plates. Selecting possible temperature-plate combinations for each section and then combining to find correct solution.





Enriching Section:

$$\frac{Y_{n+1}}{X_d} = \frac{1-\frac{L}{V}}{1-\frac{L}{VK}} + \left(\frac{L}{VK}\right)^n \left(1-\frac{1-\frac{L}{V}}{1-\frac{L}{VK}}\right)$$

Solve for all components in distillate. From desired values of X_d find Y_{n+1} and ΣY_{n+1}. Correct value of ΣY_{n+1} is found from feed plate computations. Plot Φ_E (see graph) and ΣY_{n+1} vs n at different temperatures. From correct ΣY_{n+1} construct curve of Φ_E vs n.

Stripping Section:

$$\frac{X_m}{X_b} = \frac{1-\frac{V}{L}}{1-\frac{VK}{L}} + \left(\frac{VK}{L}\right)^m \left(1-\frac{1-\frac{V}{L}}{1-\frac{VK}{L}}\right)$$

Solve for all components in bottoms. From desired values of X_b, find X_m and ΣX_m. Correct value of ΣX_m is found from feed plate computations. Plot Φ_s and ΣX_m vs m. From correct ΣX_m construct curve of Φ_s vs m.

Feed Plate Mesh:

$$\Phi_E\,\Phi_s = \left(\frac{X_d}{X_b}\right)_{\text{light key}} \left(\frac{X_b}{X_d}\right)_{\text{heavy key}} \left(\frac{\text{K heavy key}}{\text{K light key}}\right)_m$$

First two ratios from desired products.

K ratio is relatively independent of temperature.

With last equation and values of Φ_E and Φ_s from graphs construct plot (see left) to determine minimum and correct total plates.

Note: X_d is used to designate mole fraction in distillate because Smith used this symbol. The notation system used in other methods would employ Y_d instead.

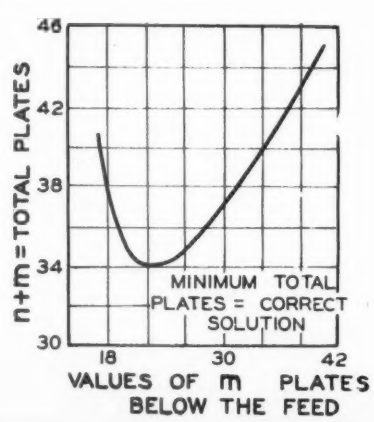
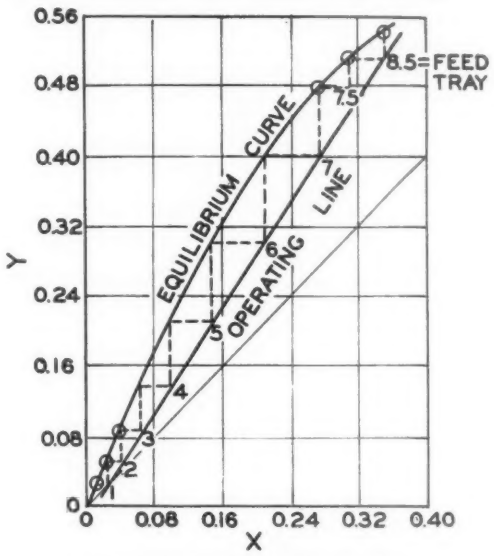


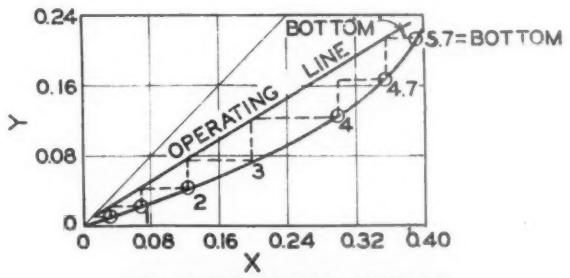
TABLE 73

SUMMARY OF JENNY METHOD

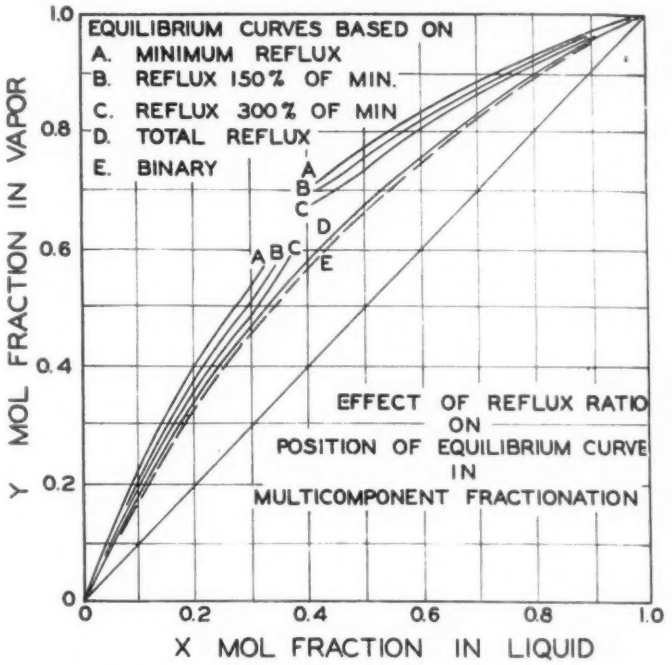
Graphical method using XY diagram, similar to McCabe-Thiele, with empirically derived equilibrium lines for key components, compensating for presence of other components, and with actual operating lines.



XY DIAGRAM FOR PROPANE IN STRIPPING SECTION



XY DIAGRAM FOR BUTANE IN ENRICHING SECTION



Equilibrium lines:

Constructed for each section by drawing curves through points determined at both ends of section in question by plate-to-plate calculations, using light key in stripping section and heavy key in enriching and starting with estimated terminal condition.

Operating lines:

Slopes from L/V ratios in respective sections. Intercepts by values of X and Y desired at product ends of the column and with corresponding values of X and Y at feed plate or mesh point of enriching and stripping sections.

Effect of reflux:

From completed calculations the graph shown above may be constructed to show the effect of reflux.

mediate reflux ratio. The equations and graphs for applying this method are given in Table 71.

The most difficult computation in this method is that of finding the minimum reflux ratio. This may be done by Colburn's method, as shown in Table 71, or by other methods. The empirical correlation relating reflux ratio and plates is the same regardless of which method is used to establish the limits because the correlation is largely based upon binary separation, for which the minimum reflux can be accurately calculated with ease. In their paper presenting this method, the authors outlined a minimum reflux method. The Colburn method is preferred, or was until the two latest methods, namely Scheibel-Montross and Bailey-Coats, were presented. Further investigations might prove the latter methods more satisfactory.

An objection to the Brown-Martin empirical method is that it does not locate the feed plate. This is not too serious because it is the custom to install alternate feed points. Because of its rapidity, after the minimums are established, this method may be used to supplement or precede a more rigorous design method.

Example 37. As an illustration of the Brown-Martin method, the number of plates with a reflux ratio of 1.5 will be computed for the problem used in previous examples.

The required data for solving this problem are obtained from previous examples. First the values of L/V are found:

Reflux ratio	$(L/D)_{min.}$ = 0.95	(L/D) = 1.5
$(V/L)_s$	2.03	1.667
$(L/V)_e$	1.77	1.48

With the values of L/V the reflux function is found as follows:

$$\frac{J}{J_{min}} = \frac{\left[\left(\frac{L}{V}\right)_s \left(\frac{V}{L}\right)_e - 1\right]}{\left[\left(\frac{L}{V}\right)_s \left(\frac{V}{L}\right)_e - 1\right]} \begin{matrix}\text{Intermediate Reflux} \\ \text{min. Reflux}\end{matrix} = \frac{(1.48)\ (1.667) - 1}{(1.77)\ (2.03) - 1} = 0.563$$

With this value of J/J_{min} the value of $N/N_{(R=1)}$ is found from the graph in Table 71. A value of $N/N_{(R=1)} = 1.47$ is obtained. In example 30 the minimum plates at total reflux was found to be 10.4. Therefore,

$N = 10.4 \times 1.47 = 15.3$ total theoretical plates, including the reboiler and condenser.

This 15.3 is to be compared with 17 total equilibrium stages found in the plate-to-plate examples in Part 12.

GILLILAND EMPIRICAL METHOD

In 1940, Gilliland[8] published a similar empirical method to the Brown-Martin method described above. It is apparent that these two empirical developments were being done independently and simultanously, both because of the

dates and the nature of the correlations and because both works were completed and submitted before either appeared in print.

Gilliland's correlation was developed in the same manner described above for the Brown-Martin method, i.e., the results of rigorous calculations for many separations, mostly binary were correlated and then checked for multicomponent systems. The resulting correlation is given in Figure 53, which is a little simpler to use than the Brown-Martin correlation.

In applying this method, it is also necessary to estimate the minimum reflux and minimum plates. Gilliland suggested a minimum reflux method but the Colburn method is preferred.

Example 38. As an illustration of this method ,the same problem solved in the previous example will be solved by the application of Fig. 53.

The reflux ratio function is first evaluated, as follows:

$$\frac{(L/D)-(L/D)_{min}}{(L/D)-1}=\frac{1.5-0.95}{1.5-1}=0.22$$

Next, a reading from Fig. 53 gives a value of 0.42 for the plate number function, giving

$$\frac{N-N_{min}}{N-1}=0.42,$$

from which, upon using $N_{min}=10.4$, $N=18.6$ total theoretical plates including reboiler and condenser.

This is to be compared with 17 total equilibrium stages from the plate-to-plate calculations. For this particular problem the Brown-Martin method was 2 plates low and the Gilliland method was 1.6 plates high. An average would have been correct. It is very little extra work to apply both rather than just one of the empirical correlations for any problem once the limiting values are known.

SMITH APPROXIMATION METHOD

The method, which was proposed in 1941, is somewhat tricky. It involves applying to each section, i.e., enriching and stripping, average or over-all equations using assumed conditions and then selecting the correct solution by criteria described. This method is summarized in Table 72.

It will not be worthwhile to give the complete derivation of the equations for this method. Readers interested may refer to Smith's original article[13]. The procedure followed in developing and applying this method will be outlined below. The equations given in Table 72 are for the following conditions: (a) constant L/V ratio in each section; (b) saturated liquid feed and (c) average vapor-liquid equilibrium ratios (K=Y/X) for each section.

A rigorous and complete equation for the change of composition across a section of a fractionator employs the L, V and K values on each plate. This makes a rather complex equation which Smith simplifies by using overage over-all L, V, and K values, thus obtaining the equations for each section shown in Table 72.

These equations are applied with a fixed average L/V and V/L ratios for several assumed temperatures and numbers of the theoretical plates. This is done for both sections, considering only the components that actually appear in the distillate in the enriching section calculations and only those that apepar in the bottoms in the stripping section calculations. The correct solutions are selected from the several in the method illustrated by the graphs in Table 72.

Referring to the graphs in Table 72, the lines of constant temperature represent three trial temperatures for each section of the fractionator. For each assumed temperature the values of Y_{n+1} (or X_m) are found by the equations shown and using the product composition for each of the components involved, i.e., the heavy key and lighter for Y_{n+1} and the light key and heavier for X_m. Then values of ΣY_{n+1} are plotted against n (ΣX_m vs m) as shown in the lower portion of the top two graphs. The correct values of ΣY_{n+1} and ΣX_m, found by another calculation, are marked on the plot, thus determining the values of ΣY_{n+1} and ΣX_m may be found by the preliminary feed plate computations shown in Table 57 of Part 12, or they may be made by equations given by Smith. The later are not included here to avoid confusing the reader. The information given in Table 72 on the Smith method is all that is necessary in addition to the preliminary steps (Part 12) for applying this method.

From the equations, the ratios ϕ_E and ϕ_S are found and plotted against n and m, as shown. The correct value of ϕ_E (or ϕ_S) for each assumed over-all temperature is found by the graphical method illustrated. As can be seen, the correct value of ϕ_E for any given temperature is at the number of plates corresponding to the correct value of ΣY_{n+1} for that temperature. The points of correctness are indicated by small circles. These are connected by dashed lines, showing how the upper points are obtained from the lower ones.

Next, the enriching and stripping section calculations are combined to give the complete solution. This is done by making a feed plate mesh calculation for the key components and plotting the total plates vs. the number in one of the sections. The correct solution is the one for the minimum number of plates (see graph in Table 72) and for which the feed plate mesh gives the desired ratio of keys in the products.

This method shows more plates required for a given separation than the results of plate-to-plate calculations.

TABLE 74.

SUMMARY OF FEED PLATE CALCULATIONS

Equations and procedure for estimation composition of feed plate vapor and liquid and the feed plate temperature for fractionation of multicomponent mixtures.

(See Part 12 for development of equations and details of application)

Feed plate temperature and composition estimated by method based on the fact that certain components do not change in concentration in going across a tray in the zones of constant composition (pinch points). This phenomenon expressed in the form of component material balances gives the following equations:

Enriching	*Stripping*
$\frac{l}{d}\left[\frac{KV}{L}-1\right]=1$	$\frac{v}{b}\left[\frac{L}{KV}-1\right]=1$
when d approaches zero	when b approaches zero
$\frac{KV}{L}$ approaches unity	$\frac{L}{KV}$ approaches unity

The above equations are applied in the following manner:

Temperatures:

The temperatures of the top plate of the stripping section and the bottom plate of the enriching section are estimated from the pinch point temperatures.

At the enriching section pinch K = L/V for the heaviest components appearing in the distillate.

At the stripping section pinch K = L/V for the lightest components appearing in the bottoms.

These conditions establish pinch temperatures.

Compositions:

Mols of heaviest components in vapor from stripping section are found by solving v_m in the above stripping equation.

Mols of lightest components in vapor from stripping section are found by solving the above enriching equation for l_n, the mols of these lightest components in liquid from enriching section, and then translating to v_m by material balance.

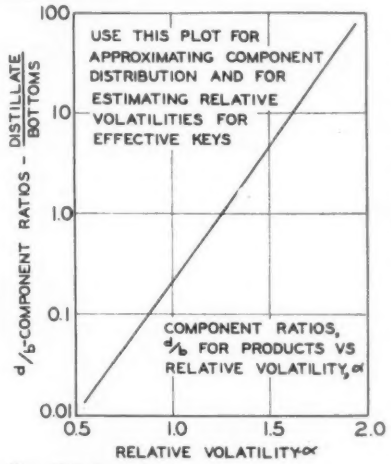
Mols of intermediate components in vapor from stripping section estimated by phase equilibria calculation.

Check feed plate temperature by dew point of vapors.

TABLE 75

SUMMARY OF HENGSTEBECK METHOD

Graphical method using XY diagram, similar to McCabe-Thiele, with equilibrium line constructed from K constants of key components (or effctive keys) and with operating lines based on neglecting the lightest and heaviest components, respectively, in the stripping and enriching sections.



Equilibrium line:

Constructed from "K" constants of key or effective key components by following relations, "G" and "H" being the keys.

$$X_G = \frac{1 - K_H}{K_G - K_H} \text{ and } Y_G = K_G X_G$$

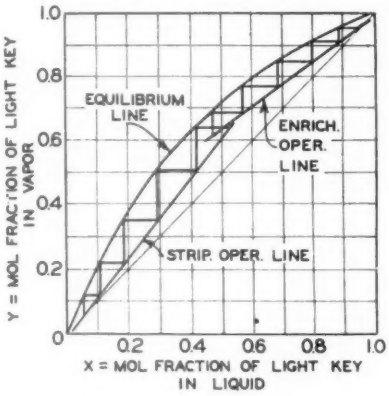
When keys consist of several closely grouped components, construct equilibrium line for effective keys and estimate "K" values from plot of α vs d/b (see sample plot).

Operating lines:

Slopes computed at pinch or maximum concentration points, neglecting components that disappear a few trays away from pinch points and do not participate in the fractionation further. Intercepts from desired concentration of keys in products.

Enriching section operating line:

Slope = L/V ratio at upper pinch point (i.e. K = L/V for heavy key), neglecting quantities (liquid and vapor) of all components less volatile than the heavy key.



Intercept — from key component compositions desired in products, neglecting all other components than the keys.

Stripping section operating line:

Slope = L/V ratio at lower pinch point (i.e. K = L/V for light key), neglecting quantities (liquid and vapor) of all components more volatile than the light key.

Intercept — from key component compositions desired in products, neglecting all other components than the keys.

Graphic solution:

Illustrated by sample XY diagram.

JENNY GRAPHICAL METHOD

In 1939, Jenny[10] proposed a graphical method of making multicomponent fractionation calculations, which involved constructing a modified equilibrium line to allow for the effects of the presence of the non-volatile lighter-than-key and heavier-than-key components. In 1945, Jenny and Cicalese[11] showed the effect of reflux ratio on the XY diagram of the key components in multicomponent fractionation. These two contributions to the technical literature on this subject have been summarized in Table 73 under the heading of "Jenny Method."

The principle of the Jenny method is similar to the Sherwood graphical method for absorption and stripping design (see Part 6, *The Petroleum Engineer*, October, 1947) in that both construct an equilibrium line from the least number of calculations possible and use a straight operating line. As shown in the larger plot in Table 73, the reflux ratio affects the location of the equilibrium line appreciably. The effects of reflux ratio and the presence of non-distributed components are all taken into consideration at the same time in the method Jenny uses to obtain the equilibrium curves. It is necessary to construct separate diagrams for the enriching and stripping sections. This is done for the key components, using the light key for the enriching section and the heavy key for the stripping section.

The equilibrium curves are obtained by making a few plate-to-plate calculations from both ends of the section involved. This requires knowing the feed plate liquid and vapor compositions, which are computed in the preliminary steps outlined in Part 12. The feed plate calculation steps that were developed and illustrated in Part 12 (see Table 57), are summarized in Table 74. The operating lines are drawn by the L/V ratios and the desired product compositions.

Having the equilibrium and operating lines for both enriching and stripping sections permits making the stepwise calculations necessary to connect the few plate-to-plate calculations made at the ends of each section. In this method it is necessary to assume a reflux ratio in order to construct the XY diagrams. In making this reflux ratio assumption, Jenny uses the minimum value as a criterion. Jenny's method of finding the minimum reflux ratio involves calculating the minimum quantities of components in the feed plate vapor for assumed values of L/V and checking temperatures.

HENGSTEBECK GRAPHICAL METHOD

This method, which was proposed in 1946, also employs an XY diagram but in this case the operating line rather than the equilibrium line is specially constructed. Hengstebeck[9] proposes drawing the equilibrium line from the vapor-liquid phase equilibrium relationship for the key components, neglecting the lighter and heavier components.

The operating lines are constructed from slopes calculated at the pinch points by neglecting the components that disappear a few plates away. In other words, the enriching section operating line has a slope of L/V for all components except those less volatile than the heavy key at the upper pinch point. Likewise, the stripping section operating line slope is calculated at the lower pinch point in a similar fashion. The end points of the operating lines are located by means of the proportions of the keys in the terminal products: i.e., neglecting the other components.

This method is summarized in Table 75, wherein a method suggested by Hengstebeck for approximating the component distribution and estimating the relative volatilities of effective keys is also illustrated. The "effective keys" feature of this method may be employed with other procedures. When the separation is between two groups of close boiling components, as in a debutanizer, for example, it is necessary to employ two effective keys, consisting of several components each, in constructing the XY diagram and applying this method.

Hengstebeck suggested plotting, on semi-log scales, the ratio d/b versus relative voltaility, α. This plot is essentially straight so it is drawn straight from the α data and the desired split. Then the components are lumped together to get the "effective keys," thus giving d/b ratios for these two effective keys. From these d/b values, the relative volatilities are obtained from the graphs. These α values will, of course, be referred to the reference component chosen, which will be neither of the keys but that will not matter in the construction of the equilibrium line.

Because of the shortage of space and time this method will not be illustrated by an example, either. It is of interest to consider the Jenny and Hengstebeck methods together because of the way the two of them illustrate the fundamentals of fractionation calculations.

● **References.** Literature references were given at the end of Part 14.

Part 16 will be published soon.

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T-48-7

Construction of cable tool bit forges

By FERD J. SPANG, President, Spang & Company

EXCLUSIVE

ONE of the phenomena of steel is that it must be heated properly for both forging and hardening to preserve its homogenous quality. In very simple language, this means that it must be heated neither too rapidly nor too hot, nor in an atmosphere that will decarbonize or over-oxidize it.

Thus, the construction of the forge and the manner of mixing and burning the fuel become of paramount importance in the preparation of the drilling bit for its maximum usefulness.

A fuel mixture containing a surplus of air (oxygen) that has not been consumed by reaction with the fuel, or that was not properly mixed with the fuel to develop such a reaction, will cause heavy scale to form and collect on the bit and excessively oxidize and decarbonize it. A fuel mixture that is thin or short of fuel burns with a raw, sharp flame.

Because of its extremely high temperature, such a flame will heat the surface of the steel at an excessive rate. However, this heat cannot be absorbed into the body of the steel more rapidly than its normal conductive capacity permits; thus the exposed corners are frequently burned long before the interior of the steel is hot enough to yield to forging movement. Consequently, forging is limited to the movement of the surface. It is the forging from this type of heat that causes feather edge wearing surfaces with wrinkles or seams behind them and clogged-up water courses with subsequent corner and water course breakage.

Forging after such thin or shallow heats frequently ruptures cleavage areas and radically alters the fiber direction. If the heating is continued long enough to produce malleability in the interior of the steel for forging, it will not only burn the corners but will frequently cause such a large grain growth that the bit will burst open or the end fall off when it is struck with the sledge.

On the other hand, a mellow flame in which all the oxygen of the air has been consumed by its reaction with the fuel will heat the steel slowly, and normal conductivity will carry sufficient heat to the interior of the steel to produce proper forgeability. As it is rich in fuel, it will not form heavy scale nor unduly decarbonize the steel.

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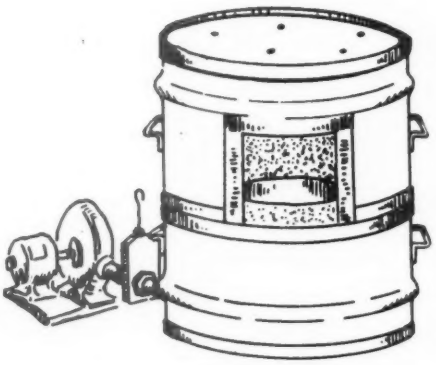


FIG. 1. Assembled forge.

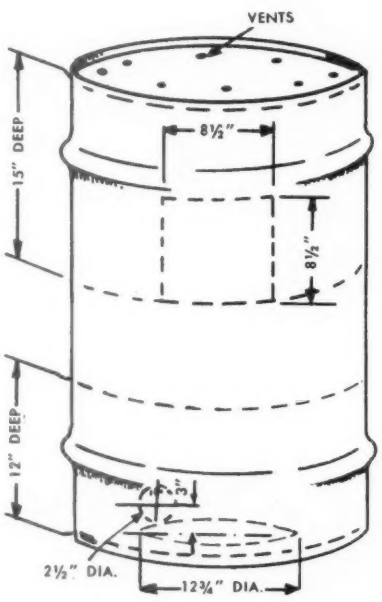


FIG. 2. Method of preparing outside shells. Cut drum on dotted line. Use inside measurements. Drill ¼-in. vents in top.

Such a heat will permit the bit to be dressed with a minimum of effort and but a slight loss from scaling and burning. The bit can easily be upset or stoved up to give any desired form without disturbing the grain cleavage areas or materially changing the fiber structure within its body. Cracks will not develop in the heel of the wearing surface, nor will they be of the short-lived feather edged variety. Water courses will not close to any bothersome degree, with the result that they can easily be kept fully open by a few blows of the pein of the sledge or by the use of a hand fuller at each dressing.

Much steel that is wasted by trimming edges, water courses, etc., as a result of heating with thin mixtures will be saved by using a rich or mellow fuel mixture. Thus the operator will save steel, time, and physical labor.

The problem then resolves itself principally into that of selecting a proper forge design and a correct method of mixing and of burning the fuel. Again stated in very simple language, this means that there must be sufficient fuel in the path of the blast air to consume all its oxygen by reaction with the fuel before it reaches the bit. Thus combustion must take place a sufficient distance away from the bit and in such a turbulent manner as to avoid the possibility of eddy currents carrying free air past the fuel to come into contact with the corners of the hot steel to form incandescent combustion points upon them.

In the burning of liquid or gaseous fuels, the fuel and blast air portions of the mixture flow at constant rates over any desired period of time. However, they must be proportioned in the correct relationship to each other to produce a mellow flame, be mixed in such a manner as to be uniform, and injected into a combustion chamber designed to consume fully the air in advance of the heated atmosphere blanketing the bit.

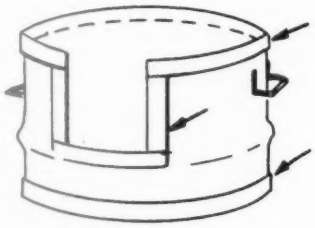
When solid fuels are burned the problem is similar, except that solid fuels do not flow. Consequently, somewhat in excess of the total fuel requirement for a specific heat must be charged into the fire box before the heat is started. If this is not done, additional fuel must be added during the heat, and this is seldom done until the corners of the bit are being burned.

Combustion is the chemical reaction of the oxygen contained in the air with the hydrocarbons contained in the fuel. Consequently, if there is not at all times sufficient fuel in the path of the blast air to consume the oxygen fully as it moves into the heating area, this unconsumed oxygen will react with the combustible or oxidizing elements of the hot steel to oxidize it and to burn it.

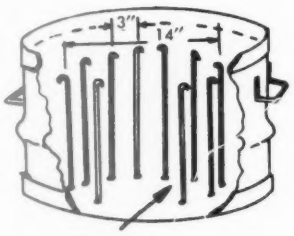
Since carbon is combustible and as the iron base of the steel is readily subject to oxidization, it follows that both carbon and iron will tend to unite

FIG. 3.

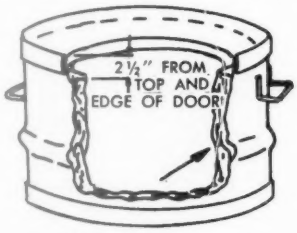
HOOD



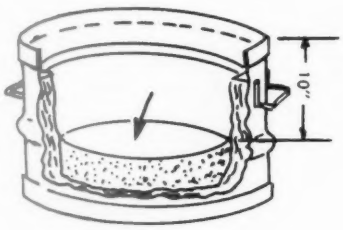
STEP NO. 1
Turn hood upside down.
Weld ½-in. by 2-in. band around cut lines of hood and attach handles.



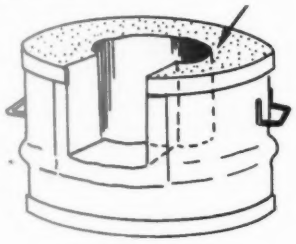
STEP NO. 2
Weld ¼-in. to 3/16-in. anchors in hood on 14-in. diam. centers with 3-in. spacing.



STEP NO. 3
Put mixture of 50 per cent fire clay and 50 per cent asbestos wool 2-in. thick inside of hood.

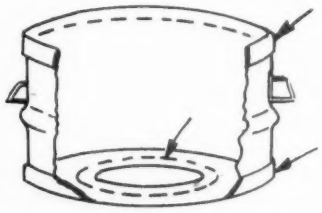


STEP NO. 4
Put refractory cement in top of hood leaving 10-in. space.

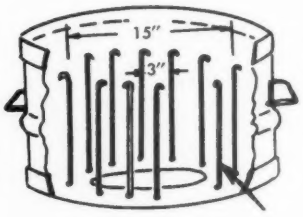


STEP NO. 5
Place form in hood and wrap No. 16 wire around anchors and ram remaining space full of refractory cement.

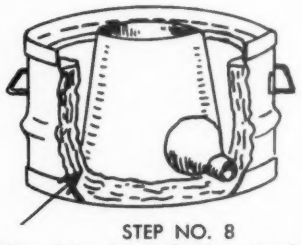
COMBUSTION CHAMBER



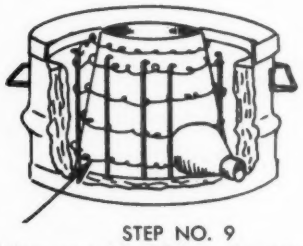
STEP NO. 6
Weld ½-in. by 2-in. band around cut lines at top and outside of bottom opening—attach outside handles.



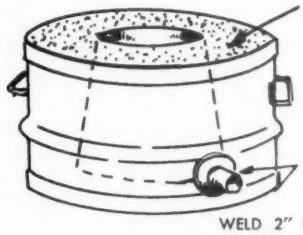
STEP NO. 7
Weld ¼-in or 3/16-in. anchors in combustion chamber on 15-in. diam. center line with 3-in. spacing.



STEP NO. 8
Place lining in combustion chamber and put in asbestos fire clay mixture. Keep down 2½-in. from top.



STEP NO. 9
Wrap some No. 16 iron wire around anchors.



STEP NO. 10
Fill remaining space with refractory cement.

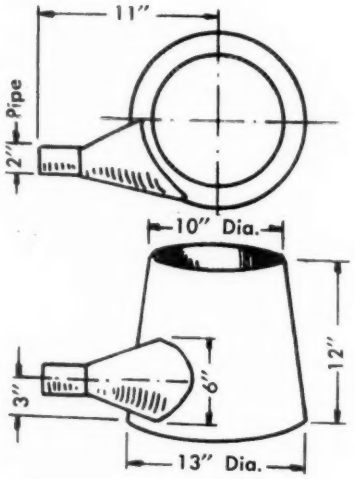


FIG. 4. Combustion chamber form. Open both ends.

with this unconsumed oxygen as definite losses. As these reactions add to the generation of heat, it also follows that the burning of the steel is accentuated.

It seems apparent, therefore, that when solid fuels are burned the fuel bed must be deep enough to permit a charge of fuel that will materially exceed the actual fuel requirements of the specific heat. Only thus can one be sure that there will be sufficient fuel left at the end of the heat to consume fully all the free air at this very dangerous time in the heating cycle.

It is also apparent that a combustion chamber for burning liquid and gaseous fuels should be deep enough and of such shape as to mix thoroughly the components and consume fully the blast air before it reaches the bit, and that the

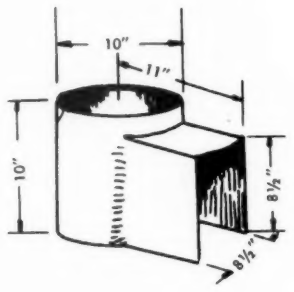
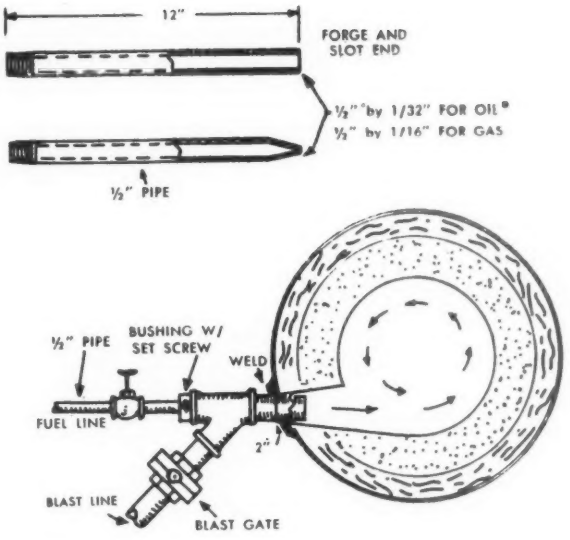


FIG. 5. Hood form. Open both ends.

fuel portion of the mixture should be somewhat in excess of the actual required portion in order that the spent gases be kept to the carbonaceous side rather than on the oxidizing side.

As the force or drive of the blast air has considerable effect upon the reaction of the oxygen contained in the air with the combustibles, it follows that the size of the blower should be somewhat proportional to the size of the combustion chamber and that it should be provided with a blast gate to reduce the



Note: Larger opening for low pressure gas.

FIG. 6. Burner arrangement.

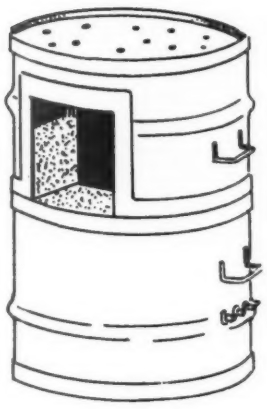


FIG. 7. Assembled forge.

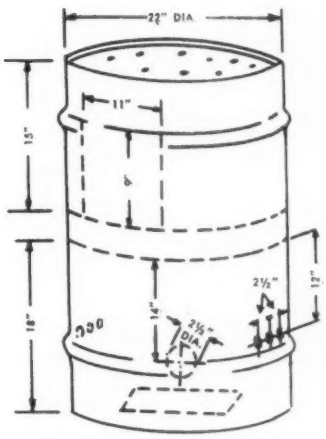


FIG. 8. Method of preparing outer shells. Cut drum on dotted lines using inside measurements. Drill ¼-in. vents on top.

volume of air for the various heating requirements.

Naturally, these elements may be computed by mathematical formulae if all factors such as Btu content of fuel, weight of material to be heated, forge area, heat losses, altitude, climatic conditions, etc., are known; but as such factors vary from area to area, specific computations would prove of little value. Therefore a fundamental understanding of the objectives would appear to be most useful to the average driller and tool dresser. With a fair understanding of these objectives by this resourceful group, the technique of heating drill bits for dressing and hardening should be materially improved*.

No particular design of forge is emphasized, as long as the fundamental conditions are adequately met and the size of the forge is consistent with the bit size.

Experience has shown that a forge for burning liquid or gaseous fuels and heating 6-in. and 8-in. bits should have a combustion chamber about 12 in. deep. This chamber should be of a hollow truncated conical shape, about 13 in. in diameter at the bottom and about 10 in. in diameter at the hearth line. The center of the fuel mixture tube should enter it about 3 in. above the floor line at the edge of the circle, to give a whirling motion to the fuel as it goes into combustion. See Figs. 4 and 6. It should have a 10-in. space above the hearth. The front opening should be about 8½ in square.

The combustion chamber may be made with or without a bottom. If made without a bottom, the forge can be set directly on the ground and banked in, or a sheet iron box can be made and filled with earth and the forge set on this fill and banked in. If made without a bottom, the scale and slag will be disposed of each time the forge is moved. If made with a bottom, the scale and slag must be removed manually each time it fills to the blast line.

The forge should be fitted with an ordinary blast blower having a 2-in. outlet equipped with a blast gate and an appropriate fuel mixer. See Fig. 6. For larger or smaller bits, the sizes of the forge and the blast blower may be changed proportionately.

Any suitable shell may be used to encase the forge, and it may be made in one, two, or three sections. An ordinary 55 gal steel oil drum is large enough to use for a forge shell for bits up to 8 in. in hole size. Such a forge is shown in Fig. 1. Directions for cutting a shell for such a forge are shown in Fig. 2. Directions for completing the forge are shown in Fig. 3, steps 1 to 10.

Iron anchors (3/16-in. welding rod or iron wire) for holding the refractory lining in place should be welded inside the shell. It should have a 2-in. lining of light insulating material such as a mixture of asbestos fiber and fire clay inside the bottom and top and inside the outer shell. This should be kept back about 2½ in. from all openings and the blast pipe.

The bottom and top should then be lined with plastic refractory material. Forms for the combustion chamber and blast entrance tube (Fig. 4) should be made of thin gauge black sheet iron and put in place after the insulating material and bottom plastic refractory cement have been placed. The remaining cavity should be filled with the plastic refractory material. A high temperature plastic refractory material, such as is used in boiler settings and the building of industrial furnaces, is satisfactory. The form for the inside of the fire hood is shown in Fig. 5. It should be used in similar manner. These forms are to be left in the forge and will burn out when it is fired. After the refractory material has been air dried, the forge should be fully dried by burning some wood in it before heating with fuel oil or gas.

The fuel mixing chamber, blast gate, fuel valve, nozzle, and combustion chamber arrangement is shown in Fig. 6. A larger nozzle opening is required for the burning of natural gas (depending upon line pressure) than for the burning of No. 1 Furnace Oil, which is the most desirable of the liquid fuels. Thus an assortment of nozzles should be available to meet various gas pressure needs. When burning oil the flame should be rather red and smoky. When burning natural gas the flame should be slightly orange. With either fuel there should be a sunflower burning in and around the door opening, thus showing that there is some excess of fuel over that required to consume the oxygen contained in the blast air.

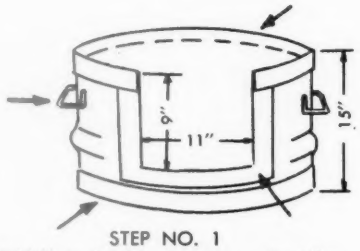
For burning solid fuel to heat 6-in. to 8-in. bits, the fire box should be rectangular, about 11 in. wide, 8 in. from front to back and 12 in. deep above the grate bars with 6 in. or more left below them for an ash pit. The door should be 11 in. wide and 9 in. high. The removable hood should have a cavity 11 in. wide, 9 in. high, and 15 in. from the front of the door to back of cavity, to provide for the retention of heat and the shielding of the bits from heat loss.

A forge for burning solid fuel may also be made from an ordinary steel oil drum as illustrated in Fig. 7. The preparatory cutting procedure is shown in Fig. 8. Directions for completing it are

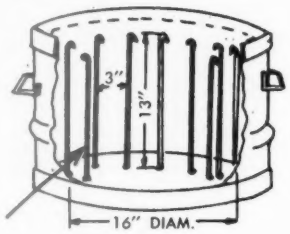
*See "The Care and Use of Cable Tool Bits," *The Petroleum Engineer*, Mid Year Issue, 1930.

FIG. 9.

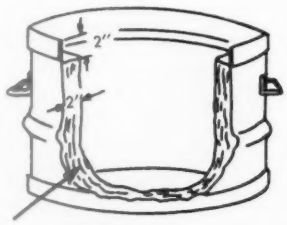
HOOD



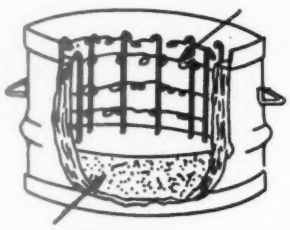
STEP NO. 1
Weld ¼-in. by 2-in. band around cut lines and bottom—attach handles.



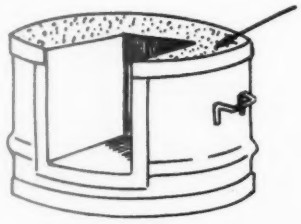
STEP NO. 2
Weld in ¼-in. or 3/16-in. anchors 13-in. long on 16-in. diam. centers with 3-in spacing. None in door opening.



STEP NO. 3
Put mixture of 50 per cent fire clay and 50 per cent asbestos wool 2-in. thick inside of hood.

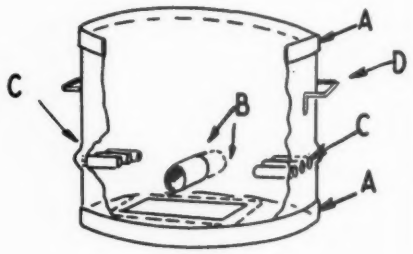


STEP NO. 4
Put refractory cement in top of hood leaving 9-in. space. Wrap some No. 16 iron wire around anchors.

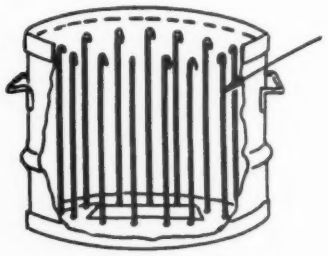


STEP NO. 5
Put hood form in place. Fill remaining space with refractory cement.

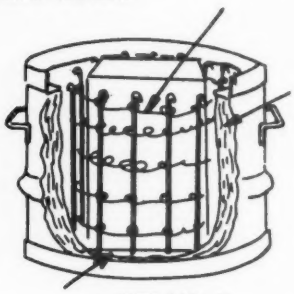
FIREBOX



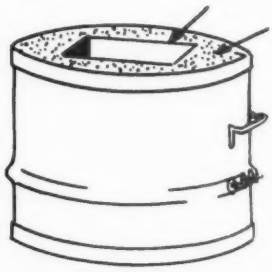
STEP NO. 6
(A)—Weld ¼-in. by 2-in. band around cut lines and bottom hole.
(B)—Weld nipple in blast hole with 3-in. of it extending outside of shell.
(C) 6 1-in. by 6-in. plain end nipples welded in grate bar holes leaving 11-in. between them for fire box opening.
(D)—Weld handles on shell.



STEP NO. 7
Weld ¼-in. or 3/16-in. anchors to bottom of fire box.



STEP NO. 8
Put mixture of 50 per cent fire clay and 50 per cent asbestos wool 2-in. thick inside of hood. Wrap some No. 16 iron wire around anchors and place fire box form over the rectangular opening in bottom.



STEP NO. 9
Put in form and fill space with refractory cement.

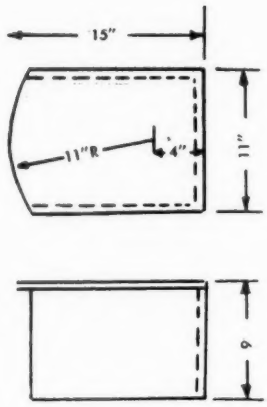


FIG. 10. Hood form.

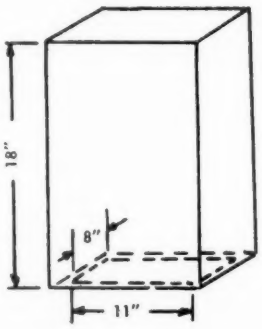


FIG. 11. Fire box form.

shown in Fig. 9, steps one to nine. A wood insert for the hood cavity is shown in Fig. 10, and for the fire box in Fig. 11.

The fire box should be open at the bottom. A cleanout hole should be provided through the earth beneath it for the removal of clinkers and ashes. Three 1-in. ID pipes should be placed through each side wall, leading from the outside to the fire box opening on 2-in. centers so that four ⅞-in. iron rods may be inserted through them and through the fire box to act as grate bars. The blast tube should enter the combustion chamber at the rear center about 3 in. below the grate bars. A blast blower with a 2-in. outlet and blast gate should be used. The size of the forge and the blower may be reduced or enlarged proportionately for smaller or larger bits.

In use, solid fuel should burn with a soft, glowing heat, and never harsh and lemon-white or incandescent. If coal is used the ashes should be dumped and quenched after each complete use. The coke secured in this way should be saved to use as covering and supplemental fuel when heating the bit. Obviously, if coke is used this procedure is unnecessary except in the interests of saving fuel and maintaining a clean fire.

Much can be gained by the drilling contractor by giving the subject of bit heating his very serious interest and attention. ★ ★ ★

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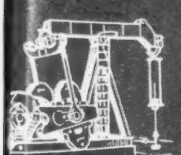

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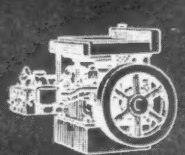

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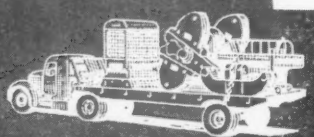

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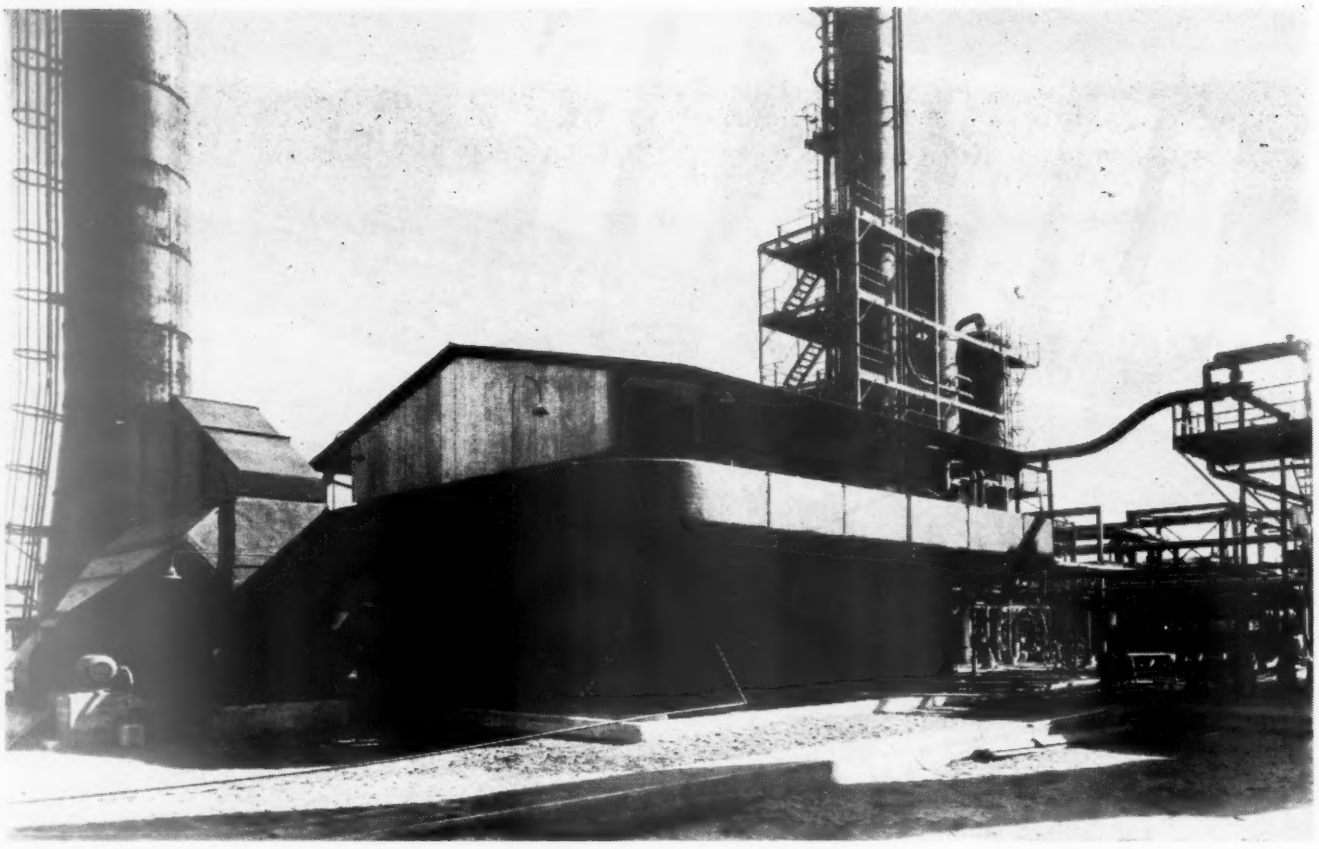

FIG. 1. Mineral wool insulated flue gas duct leads from refinery tubestill to stack.

Mineral wool insulation for processing equipment

INSULATION of equipment is one of the most important factors in maintaining an efficient petroleum processing plant. Not only is it important for the primary reason of obtaining greater heating efficiency, but it is also an effective aid in weatherproofing outdoor equipment. In addition, it is a valuable factor in minimizing temperature fluctuations; consequently it makes easier the control of processing reactions.

EXCLUSIVE

The following cases* illustrate insulation techniques that have been used to gain the above-mentioned advantages, plus others, in operating several types of equipment. Not only are large unit cases given but the everyday duct and pipe flange is also discussed. These smaller pieces of auxiliary equipment are often neglected, either because it is felt that they are too insignificant in size or because their odd shape makes them difficult to insulate. A hypothetical example showing the savings that can be made by insulating flanges, will be given.

● **Case 1.** This case is of the insulation of a medium-sized asphalt tank. It is noteworthy because electricity is used in heating the tank. As the cost of this "fuel" is notoriously high, it is doubly important that heat losses be kept at an absolute minimum.

Provision of an air space between the tank exterior and the insulation is a second unusual feature of this installation. The insulation consists of 4-in. thick mineral wool blankets encased in diamond-mesh expanded-metal lath on both sides and held together with tie wires. Narrow clips were spot welded to the tank surface on 8-in. centers so that 8-in. clip-legs stuck out from the tank. The blankets were impaled on the clip-legs to within 2 in. of the tank, thus forming the air space.

After the blankets were pressed into place, the protruding 2-in. clip-leg projections were bent over to hold each section in place. A ¾-in. coat of mineral wool insulating cement, troweled into the lath that acts as a key, forms the base for a weather-sealing asphalt coating ½ in. thick. After the insulating cement had dried through, it was covered with 1-in. poultry netting over which an asphalt seal was applied.

Normally, 2 in. of mineral wool would be recommended for a surface operating at 300-350 F, but with the high-cost energy used for heating, extra thickness is amply justified.

Considerable interest attaches to the method of heating the tank. The underside contains heating coils rated at 45 kw. Heat generated moves over the entire surface of the tank through the air space, which explains the need for the unusual arrangement described. A small heater (2.4 kw) on the delivery pipe keeps the asphalt in the line sufficiently fluid to avoid plugging.

● **Case 2.** Case 2 is of a high-temperature duct as shown in Fig. 1. The duct is a flue gas duct and leads from a refinery tubestill to its stack. It has an area of 700 sq ft and an operating temperature of 620 F.

As the duct is carrying high temperature gases and is situated out-of-doors, seven steps are required to insulate it. If it was indoors the last step could have been omitted. If it was indoors and carried heated contents at room-heating temperatures, only the first three steps would be required.

*From the files of the Industrial Mineral Wool Institute, 441 Lexington Avenue, New York 17, New York.

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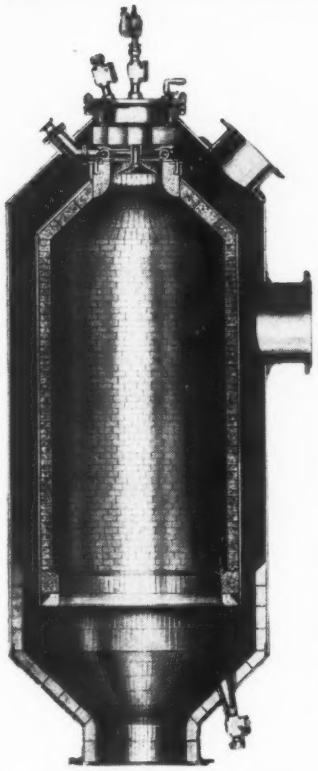

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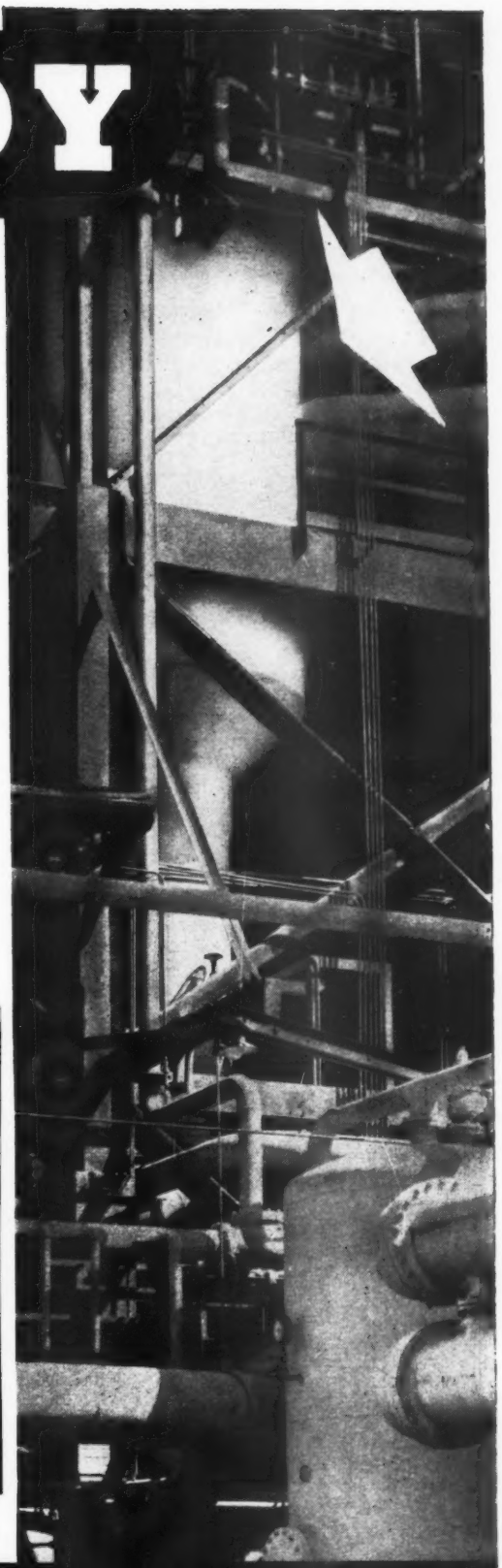

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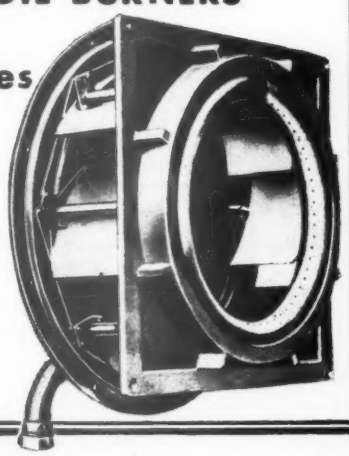

Either gas or oil may be burned alone or simultaneously in these burners. Complete control of flame characteristics by perfect air-flow, fuel-flow, and fuel-air mixing principles offers dependable and economical operation. Gas ring can be removed while burner is in operation.

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The seven steps actually required in this case are:

(1). Clean the surfaces of the duct of all grease and dirt.

(2). Cut mineral wool blocks to conform to the area to be insulated.

(3). Wire the blocks to the ducts. Galvanized or expanded metal angles are recommended to keep the blocks in line at the corners.

(4). Trowel a ½-in. coating of mineral wool insulating cement over the surface of the blocks.

(5). Follow this with a layer of 1-in. mesh poultry netting.

(6). Apply a ¼-in. coating of finishing cement.

(7). Apply at least ⅛-in. weatherproof protective coating.

The duct was operated for a time uninsulated, and after insulating, the following advantages were achieved: (1) Flue gas was maintained at a higher temperature and the draft was improved, (2) workmen were afforded protection from the heat, and (3) the duct was weatherproofed and hence its life was prolonged.

● **Case 3.** The insulation of seven butane storage tanks provided an interesting illustration of a large spherical storage tank installation. The problem was to insulate seven spheroidal butane storage tanks so that 280,000 bbl of liquid butane could be stored at 45-50 F and 20-25 psi without the use of heavy steel tanks or excessively large refrigerating units. To store the butane at atmospheric pressure would require cooling to below 32 F, and would require a great quantity of insulation and refrigeration equipment. To store without any cooling would require pressure vessels capable of handling up to 90 psi internal pressure, and would necessitate costly steel construction.

In solving the problem, the point of greatest economy was determined to be storage at 45-50 F under 20-25 psi pressure with 1 in. of mineral wool board, or block, insulation. Standard sized boards were stuck to the metal surface with hot asphalt. Galvanized wires, welded to the steel tank and projecting through the insulation, were attached to poultry netting applied to the outside surface of the boards. The finished job was weatherproofed with a troweled-on asphalt mastic coating.

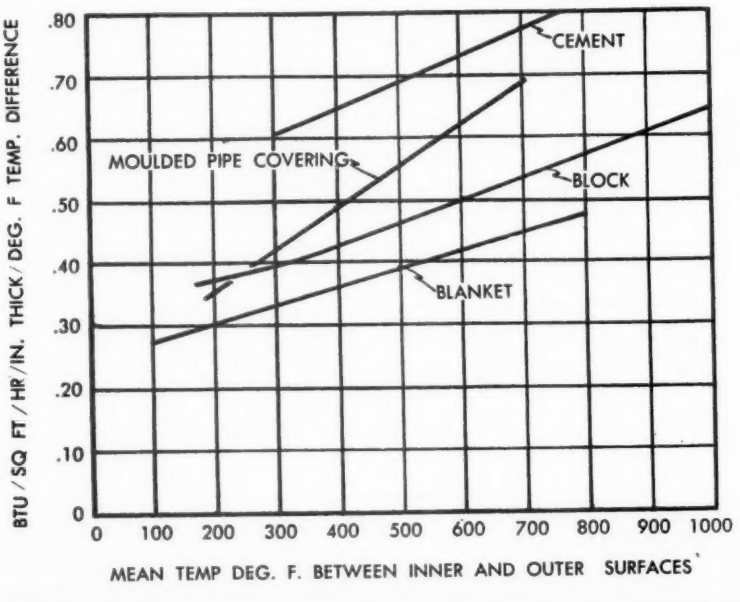
The magnitude of the job is evident from the fact that each of the seven tanks is 85 ft in diam at the equator and 65 ft high. The mineral wool boards were sufficiently pliable to fit the slight curvature of the tank surface.

● **Case 4.** Case 4 deals with perhaps the greatest Btu wasters in otherwise efficient plants — namely, flanges, valves, and fittings.

These odd shaped connections are often left uninsulated because the insulation at hand does not offer an easy method of installation. Actually, however, insulation of fittings is relatively simple. For small fittings (up to 4 in. pipe size) insulating cement can be built up in separate coats of about ¾ in. to a thickness equal to the insulation on adjacent piping.

FIG. 2. Vacuum fractionating column.

FIG. 3. Graph showing thermal conductivity of mineral wool insulation.



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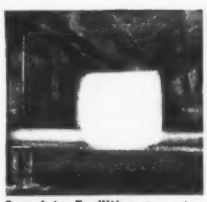

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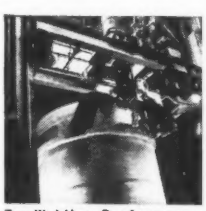

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Generally speaking, there is comparatively little difference in competing heat exchangers—either in essentials of design or of manufacture. The only difference is in the *degree* to which those essentials are carried *into the final end product.*

Wide experience should be considered a fairly definite guarantee that these essentials will be incorporated to their fullest in the units proposed for any particular job.

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Out of all of this background of experience, a system has been developed by Kellogg that guarantees the incorporation, into each design, of the most modern knowledge of how to effect heat exchange. Further, Kellogg has developed manufacturing techniques that insure a quality of final product with comparatively higher operating efficiency and lower maintenance costs. May we tell you more about this?

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For larger fittings, blocks of insulation can be cut and notched to conform to the given contour, wired in place, coated with an insulating cement, and finished with a protective covering (canvas indoors; sheet metal, roofing felt, or asphalt outdoors).

As the small size is often deceiving with regard to how much heat can be dissipated by flanges, valves, and fittings, the following hypothetical example is given.

Assuming 10 sets of 6-in. companion flanges having a bare surface area of 1.82 sq ft each and operating at 350 F. Assume each flange is insulated with 2 in. of insulating cement.

The bare heat loss = 798 Btu × 1.82 sq ft × 8760 hr = 12,722,673 Btu/yr (Kent, page 3-64).

The insulated loss = 64 Btu × 2.73* sq ft × 8760 hr = 1,530,547 Btu/yr (Kent, page 3-67).

Subtracting, 12,722,673 less 1,530,547 = a saving of 11,192,126 Btu/yr.

Assuming the use of an oil fuel having a heat content of 145,000 Btu per gal, and assuming an operating efficiency of 60 per cent, the saving is equivalent to 1286 gal of oil per year. At present insulation, labor, and fuel costs, the installation would pay for itself in about seven months.

*50 per cent added to bare surface area to get outside area after insulating.

● **Case 5.** A vacuum fractioning column (Fig. 2) built in 1942 represents another type of equipment that must be insulated.

This particular tower is run under 28-in. Hg vacuum at temperatures that range, approximately, from 725 F at the base to 400 F at the top of the unit. Six major fractions are removed including high and low grades of gas, oil, wax distillate, slop wax, cylinder stock, and asphalt. To insure effective control of each fraction station, temperature gradients are closely adjusted and careful insulation is a major factor in their control.

The heavy steel-plate tower was covered with two layers of mineral wool blanket, each 2 in. thick, faced with wire mesh, backed with metal lath. Each layer was securely wired and clamped in place and the seams of the two layers were staggered to prevent through-joints that might have low insulating value. In this case the exterior metal lath was filled and coated with plastic sealing compound troweled into the lath. The entire surface was then hot mopped with two coats of asphalt mastic, to complete the weather seal.

● **Conclusion.** These cases illustrate typical applications of insulation in the petroleum industry. There would be no question of the necessity of insulating the larger units, as the savings on heating equipment—both in size and in cost of operation—are apparent. The techniques and the specialties involved in insulating these large units, however, often have odd and challenging characteristics.

Insulation of piping and ducting cannot be overemphasized as this type of equipment is an often neglected yet potent heat waster.

A good rule of thumb to follow in deciding whether or not to insulate is: "If it's too hot to touch, insulate." ★★★

UNDERGROUND COAL GASIFICATION TEST GETS UNDERWAY

APPROVAL of a contract between the Bureau of Mines and the Alabama Power Company for a second and larger cooperative experiment in underground coal gasification at Gorgas, Alabama, was announced recently by James Boyd, Director of the Bureau.

The initial joint experiment last summer showed that gases produced by burning unmined coal offer a potential source of fuel for power and raw materials for synthetic liquid fuels. If proved feasible, underground gasification offers alluring possibilities for minimizing expensive mining and for utilizing coal veins difficult or uneconomic to mine.

Cost of the large-scale field test, including Bureau expenditures and those of the company that are reimbursable, is estimated at $411,000 for a one year period. Under the contract, the company will provide engineering and operating services on an actual cost basis (without profit), and will contribute as a site for the experiment some 300 acres of Pratt seam coal averaging 40 in. in thickness.

Preliminary core drilling already is in progress to determine the composition of the ground overlying the coal, which ranges from 60 to 125 ft in depth. The next phases of the site-preparation job to be undertaken will be the drilling of five large-diameter holes to the coal bed and the driving of two parallel entries, 1200 ft from the coal outcrop into the bed and a single butt entry for an additional 300 ft. Equipment will be installed simultaneously.

Director Boyd estimated that the site-preparation work would be completed next fall.

Objectives of the experiment are:

1. To determine the quantity of coal that can be gasified from a given combustion zone and the shape and extent of the burned-out area formed.

2. To determine whether fixed outlets for product gas are practicable, either at the outcrop of the coal bed or at vertical bore holes. Various designs of inlets, outlets, and seals will be tested.

3. To determine the operating characteristics of the installation under a variety of conditions.

4. To determine the quality and quantity of product gas generated with an air blast under experimental conditions and, secondly, the quantity of tar and related products obtained.

5. To obtain information on the effect of heat on the overlying strata.

6. To obtain fundamental technical and economic information concerning plant sites, installations, and operating processes.

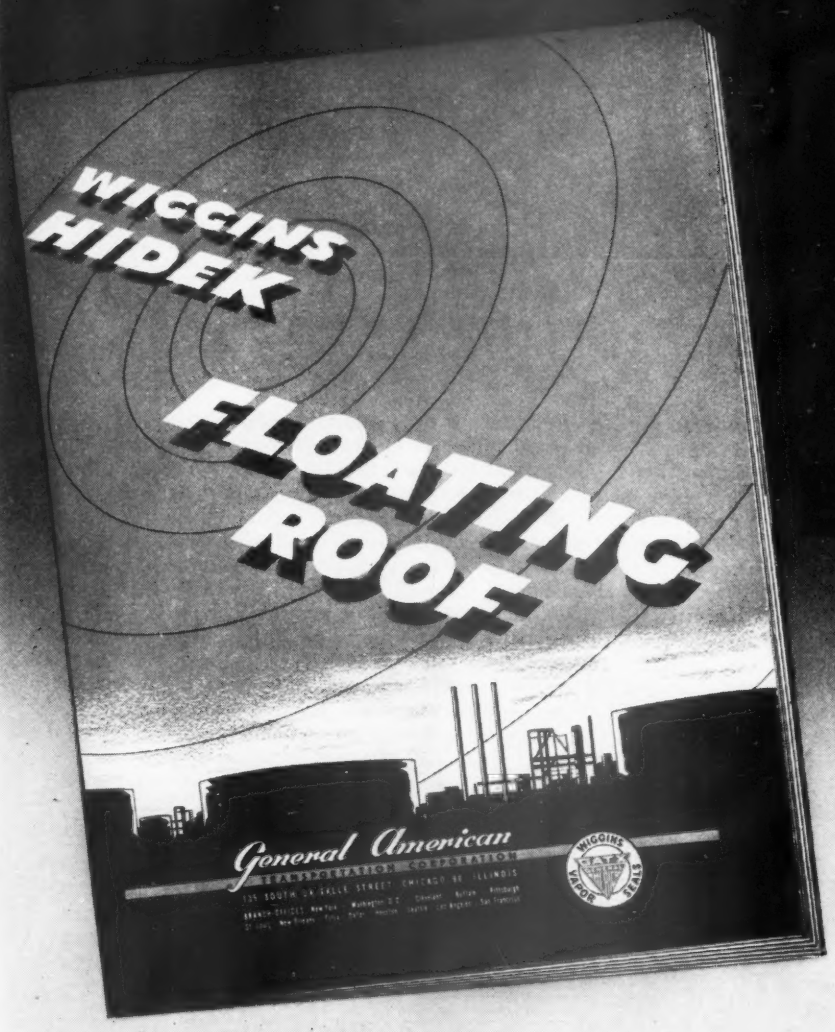
Last year's experiment produced encouraging results, Boyd said. It was shown that combustion could be maintained and controlled, that coal in place could be gasified completely, and that the roof rock would become plastic, expand, and settle down behind the burning coal face without cutting off the air or gas. The gas obtained, however, was of lower heating value than desired. This was attributed to leakage of gas and air pressure through cracks and breaks in the thin 30-ft cover over the burning coal seam.

To correct this fault, the new experiment will be carried out at a much deeper level—100 ft or more—and with much heavier air pressures and higher temperatures. These factors are expected to increase the average heat value of the gas produced with an air blast from the 47 Btu per cu ft obtained last year to from 70 to 125 Btu. Oxygen and steam can improve the gas quality further, as was shown in the first field trial when runs made with an oxygen-enriched air blast, an oxygen-air-steam blast, and an oxygen-steam blast increased the average heating value of the gas produced to 50, 100 and 145 Btu per cu ft, respectively.

Those in charge of the new experiment will be Milton H. Fies, consulting engineer and manager of coal operations for the Alabama Power Company, and James L. Elder, chemical engineer, Bureau of Mines. Under their plans, the parallel entries in the coal bed will be connected by a crosscut every 300 ft. At the center of each crosscut and at the end of the butt entry, a large diameter vertical bore hole will connect with the surface. A refractory-type fixed gas outlet and seal will be constructed at the entry portals, and the vertical bore holes also will be sealed at the surface and fitted with pipe connections for attaching the air source and product gas incinerators, or gas-usage equipment.

A fire will be started in the coal bed at the bottom of one of the bore holes by dropping an incendiary bomb down the casing as in the first experiment. Air will be forced down this bore hole under pressure by an electrically-driven reciprocating compressor with a capacity of 7300 cu ft per min. Gases will be drawn off at the next bore hole or one farther down the entry if desired. Temperature and pressure measurements taken at small test holes offset from the line of the entry will determine the progress of the fire.

If, as expected, the coal burns out between the bore holes in a cigar-shaped cavity, additional bore holes will be drilled from the surface to the widest points of the cavity curves. These holes, in turn, will be connected to the system as air inlets. In this way, the possibilities of using a vertical bore hole system to propagate the gasification over a tract of coal land will be determined. ★★★



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Automatic operation of flowing oil wells and tank batteries

By J. N. POORE, Electrical Engineer, General Electric Company

OPERATION of leases in an oil field may include 30 or more wells and their associated storage tanks and require the services of at least one operator, 24 hr a day, 7 days a week, when valves are operated manually. A minimum of four men are required, therefore, simply to start and stop the flow of oil. The cost to an oil company for each operator (lease "switcher" or "pumper") employed is $7,000 to $10,000 per year for salary, transportation, and furnished living costs. Almost all of the operations can be done by means of automatic controls that would reduce the manpower considerably.

EXCLUSIVE

The purpose of this article is to describe an automatic control system that has been installed in an East Texas oil field to control the flow of 31 flowing wells and a tank battery consisting of five storage tanks. These operations are ordinarily all manual and not automatic.

Control of the oil field consists of starting and stopping the flow of oil from the individual wells and diverting the flow from tank to tank in the storage battery. In addition, an accurate method of measuring the liquid level in the storage tanks is required.

The problem can be separated into three main functions. These are:

(1) Oil gathering.
(2) Tank battery control.
(3) Measurement of the fluid level in the tanks.

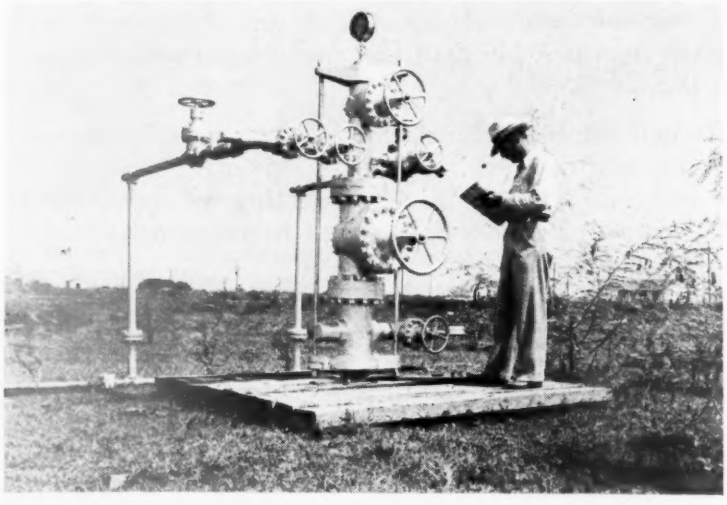
The three problems are practically independent and any one of them can be considered independently.

● **Oil gathering.** Oil is lifted from the ground either by means of pumps or as a result of the underground gas or water pressure without external aid. Wells that do not require pumping or other "artificial" lift are known as "flowing" wells." Out of the 425,000 or more wells in the United States, only about 50,000 are flowing wells.

Each well in some states is allowed to produce only a certain number of bbl per day in accordance with the proration regulation set up by the State oil regulatory commission. Some wells produce their allowable production in a few minutes, while others flow 24-hr without exceeding their quotas. The length of time that any particular well may flow varies from time to time and it is common practice to check each flowing well about once a month to determine how long the well must flow in order to produce its allowable number of barrels.

After a well has been drilled and tested as a flowing producer, the wellhead equipment, consisting of valves for starting, stopping, and throttling the flow of oil, is mounted on the top of the

FIG. 1. "Christmas Tree" at top of a flowing well.



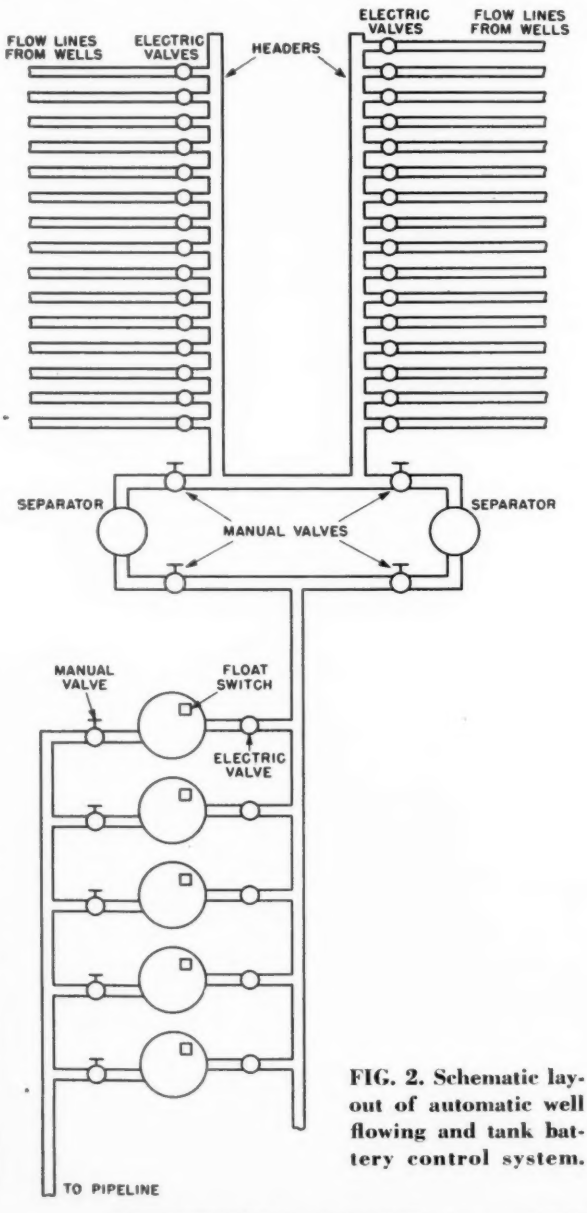


FIG. 2. Schematic layout of automatic well flowing and tank battery control system.

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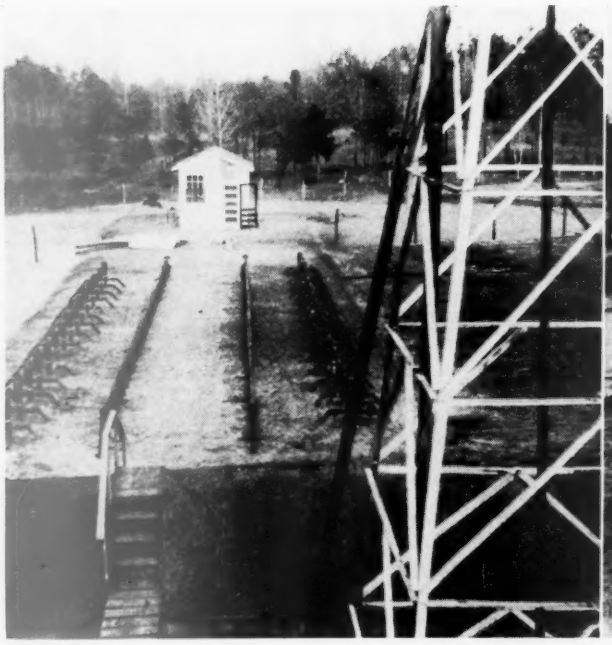


FIG. 3. View of the main header and control house.

FIG. 4. Close up of motor-operated valves in the well flow lines.

well casing. Fig. 1 shows a typical well head valve arrangement known as a "Christmas Tree." Pipe lines of relatively small diameter are run from the wellhead to a central point where the gathering tanks are located.

The "start-stop" valves for the wells may be placed either at the wellhead or at the common header near the tank battery. It is preferable to have the start-stop valves at the central point, so that the operator does not have to travel the entire field. This requires that the pipe lines from the wells to the tank battery can withstand the field oil and gas pressures, which may be up to 3500 psi. Where the flow-lines will not withstand such pressures, the start-stop valves are situated at the individual wells.

Regardless of where the start-stop valves are placed, throttling is always done at the wellhead Christmas tree. This throttling is necessary because:

(1) It tends to maintain a low gas-oil ratio for the well and, therefore, does not rapidly deplete gas in reservoir.

(2) It tends to prevent excessive sand and salt water production with the oil.

(3) It tends to prevent underground cave-ins that might make it impossible to recover some of the oil in the reservoir.

The installation described consists of 31 flowing wells and a common tank battery of five tanks. Fig. 2 shows a schematic layout of the system.

The start-stop valves are placed at the common header as shown in Fig. 3. For automatic operation, electrically operated valves are placed in parallel with the manually operated valves. These valves are motor operated, fail safe, spring closed.

Automatic opening and closing of each valve is accomplished by means of

FIG. 5. Automatic tank switching control panel with door closed.

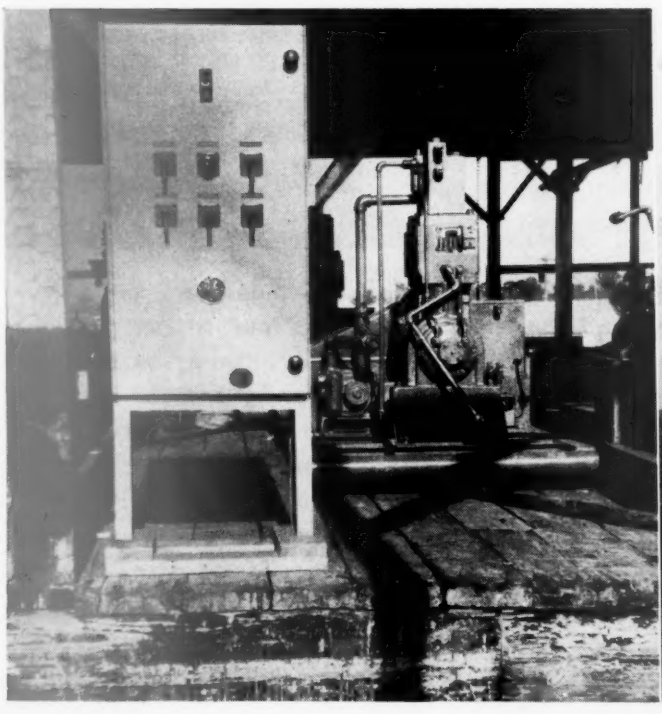
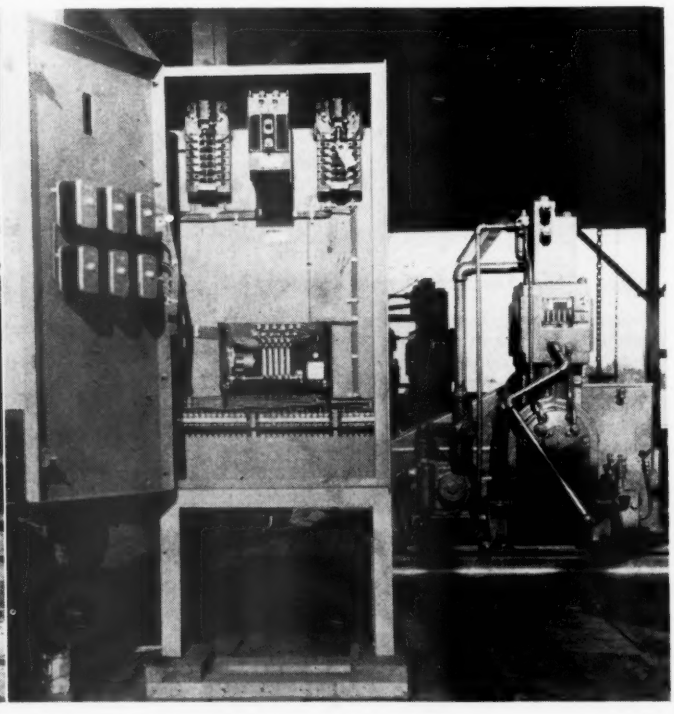


FIG. 6. Automatic tank switching control panel with door open.



Baash-Ross News

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YOU GET THESE 3 Vital advantages ONLY IN THE BAASH-ROSS EXTERNAL DRILL PIPE CUTTER

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ERSHOT ASSEMBLY
ates cutting
es and supports
section

. SPRING
ions the
ing action

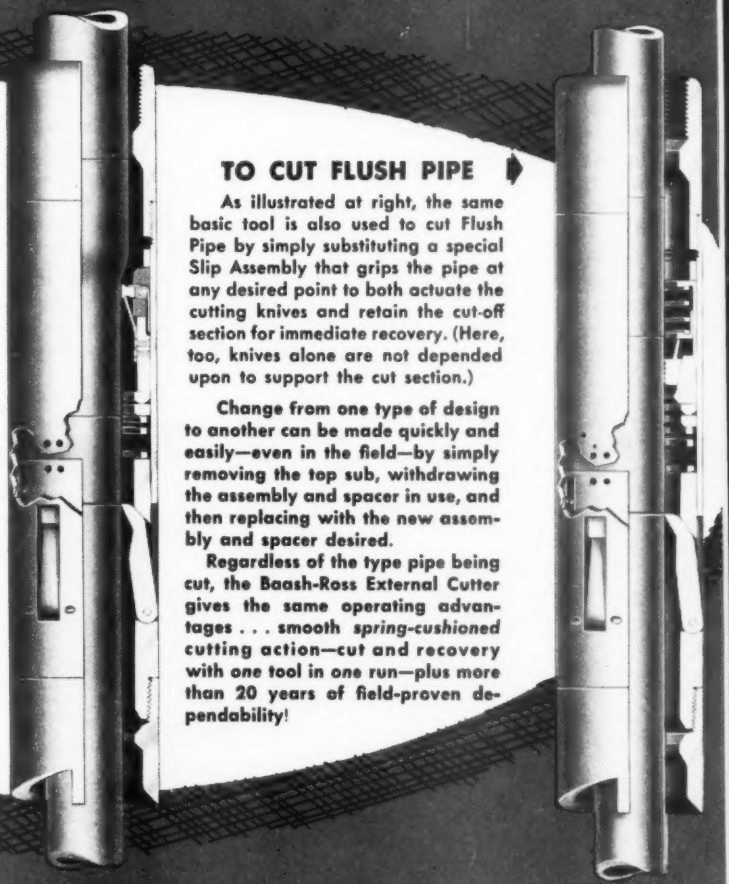
GED KNIVES
e clean smooth cut

TO CUT REGULAR PIPE

As illustrated at left, for cutting Regular Pipe the tool is made up with Overshot Springs that catch under a tool joint or coupling to both actuate the cutting knives and then retain the cut-off section for recovery after cutting. (Note that the cut section is not supported by knives alone.)

TO CUT UPSET PIPE

As illustrated at right, the same basic tool is used to cut Upset Pipe by simply substituting a special assembly with "Dogs" that catch on the taper of the upset to both actuate the cutting knives and also retain the cut-off section for recovery on the same trip. (Note again that knives alone are not used to support the cut section.)



TO CUT FLUSH PIPE

As illustrated at right, the same basic tool is also used to cut Flush Pipe by simply substituting a special Slip Assembly that grips the pipe at any desired point to both actuate the cutting knives and retain the cut-off section for immediate recovery. (Here, too, knives alone are not depended upon to support the cut section.)

Change from one type of design to another can be made quickly and easily—even in the field—by simply removing the top sub, withdrawing the assembly and spacer in use, and then replacing with the new assembly and spacer desired.

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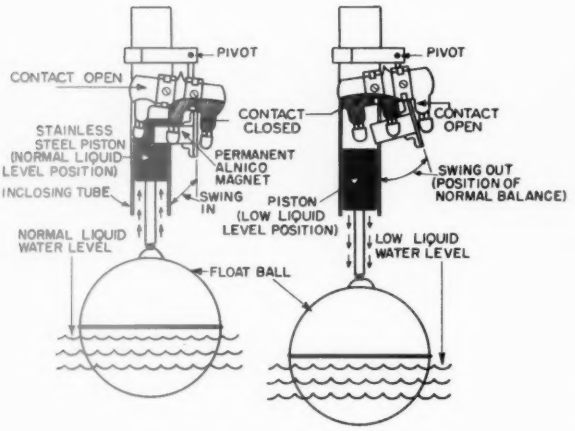

FIG. 7. Detailed view of the tank battery float switch.

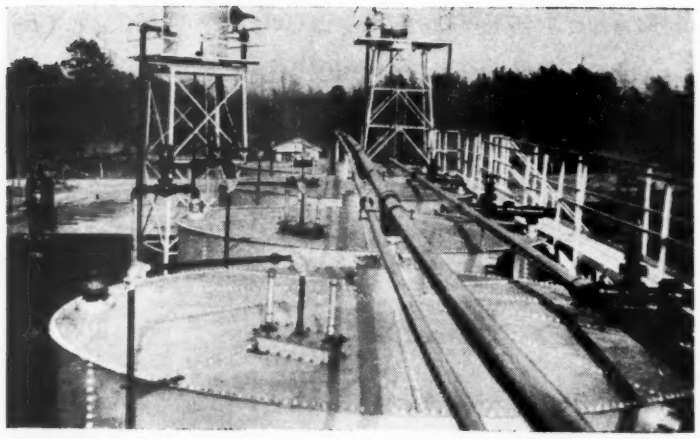

FIG. 8. View of top of tank battery with motor-operated valves at left, liquid level equipment at left center, and top float switch beneath large pipe at center.

its individual automatic time switch. The time switch has a 24-hr dial and it opens the valve one or more times each day, allows it to remain open as long as desired, and shuts it down without any attention from the operator. This control is in the small house shown in Fig. 3.

With this system, it is possible to set up the flowing time of the wells according to any prearranged schedule. The wells may be set up so that several flow simultaneously or they may be set to flow consecutively, if the combined flow periods allow. Normal practice is to spread the total flowing period over about 18 hr.

A selector switch labeled, "Off-Automatic" is used in conjunction with each time clock. When in the "Off" position, the well is not controlled automatically. Any well may be flowed manually by means of the manual valve in parallel with the automatic valve.

Each start-stop valve has a maximum flow rate of 2000 bbl per day and can withstand 2000 psi pressure. The valves are weatherproof and the electric motor-operated portions are enclosed in an explosion-proof housing. The valves shut off tightly and have seats that can be replaced easily by the operators. They require about 60 sec to open full, and 12 sec to close full. The valves are only suitable for full open or closed operation. It is not possible to obtain throttling. In this service, throttling is not necessary as it is done at the wellhead. Fig. 4 shows the start-stop valves installed in the flow lines.

● **Automatic tank battery control.** As shown in Fig. 2, the flow from the wells comes to a common header then passes through separators that remove water and gas. The oil flows from the separators into the five storage tanks. In a manually controlled field, the operator diverts the oil into a particular tank by means of manual valves. When one tank is full, he shuts off the valve in the inlet line and opens the valve of the next tank.

The operator makes out a pipe line call ticket when a tank is full, noting the height of the oil in the tank. From tank batteries, oil goes to refineries by pipe line, truck or tank car.

The automatic control installed for this tank battery accomplishes the following functions:

(1) Automatic sequencing of the filling of tanks in numerical order.
(2) Any tank already full is automatically by-passed.
(3) Any tank can be by-passed when it is not full by means of a selector switch.
(4) When a tank is ready to flow into the pipe line, it can be by-passed to prevent oil from being flowed in the tank.
(5) When all tanks are full, all of the automatic apparatus is shut down. When this occurs, the associated well flowing control is also rendered inoperative and all flow lines are shut off.

The apparatus used to accomplish these functions consists of a control panel, a motor-operated valve in each tank inlet line and a special float switch mounted in each tank.

Unless all tanks are full, the control circuit is energized. As soon as the first tank is filled, as indicated by its limit switch, a sequencing relay moves to the next tank and so on until the cycle has been completed. If some of the tanks have been emptied in the meantime, the cycle will repeat, or if all tanks remain full, the equipment will shut off until one of the tanks has emptied. The small control panel required for this system is shown in Figs. 5 and 6.

The motor-operated valves used in the tank battery inlet lines are similar in construction to the start-stop valves in the well flow lines.

The float switches mounted in the tank consist of a float-ball-operated stainless steel piston. The stainless steel piston, by magnetic attraction, tilts a mercury switch that has a normally opened and a normally closed contact. The contacts being of the mercury type are of particular advantage in this application because they assure no sparking. Fig. 7 shows the details of the float switch.

Fig. 8 shows the top of the tank battery with the motor-operated valves and float switches installed.

● **Liquid level indication.** Liquid level indication has nothing to do with automatic tank battery operation, but is necessary for accounting purposes. The lease pumper must fill out a pipe line call ticket indicating the fluid level in each tank in feet, inches and fractions of an inch, and present it to the pipe line representative. The pipe line representative likewise measures the liquid level, and the two measurements must agree within ¼ in., or the pipe line representative will not take oil from the tank. The liquid level indication must be within ¼ in., therefore, and in some instances within ⅛ in.

The usual method of measuring the oil is for the lease pumper to climb to the top of the tank, open an inspection hatch, and lower a weighted steel tape measure into the tank. The amount of oil in the tank is then determined by referring to a precalculated tank table.

Many attempts have been made to devise a simplified method of measuring the oil level in tanks so as to eliminate the labor on the part of the lease pumper. There has been a desire on the part of the oil companies to have a device that would accurately indicate the oil in the tank in such a way that this information could be transmitted to a remote indicating or recording station. Many devices have been tried for this purpose, but few, if any, are being used.

On this particular installation, the tank level indicating gage allows the fluid to be read on a steel tape at ground level. There is no remote indication.

This liquid level indicating gage consists of a float attached to a steel tape that rides over a series of pulleys and a tape drum on roller bearings, mounted about 5 ft off the ground. The pumper can look through a glass window at the tape going past an adjustable pointer. Accuracy is within ¼ in. as has been proved by several months' operation.

● **Conclusion.** The advantages gained by this completely automatic system are very apparent. The greatest gain obtained is the reduction of manpower. At the cost of labor today, the installation of an automatic system such as this should pay for itself very rapidly. ★ ★

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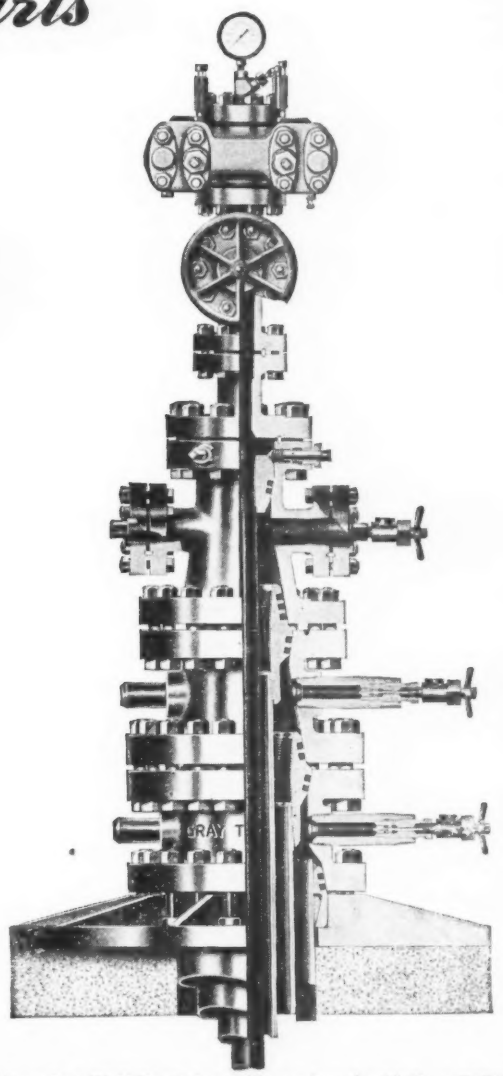

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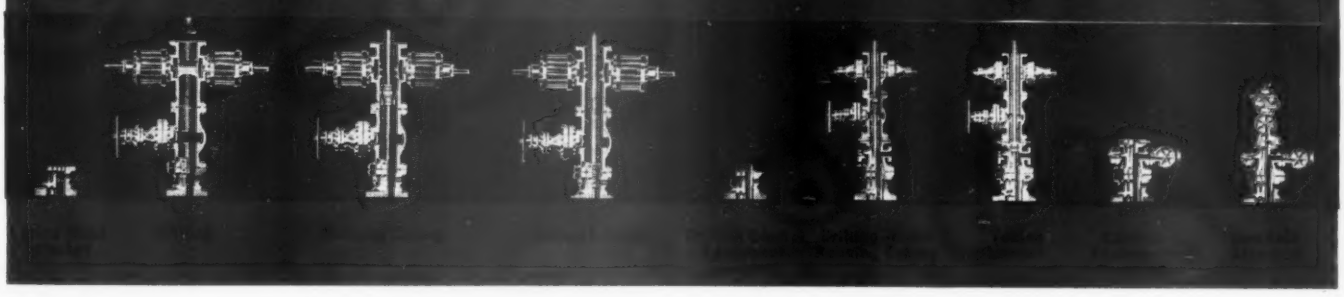
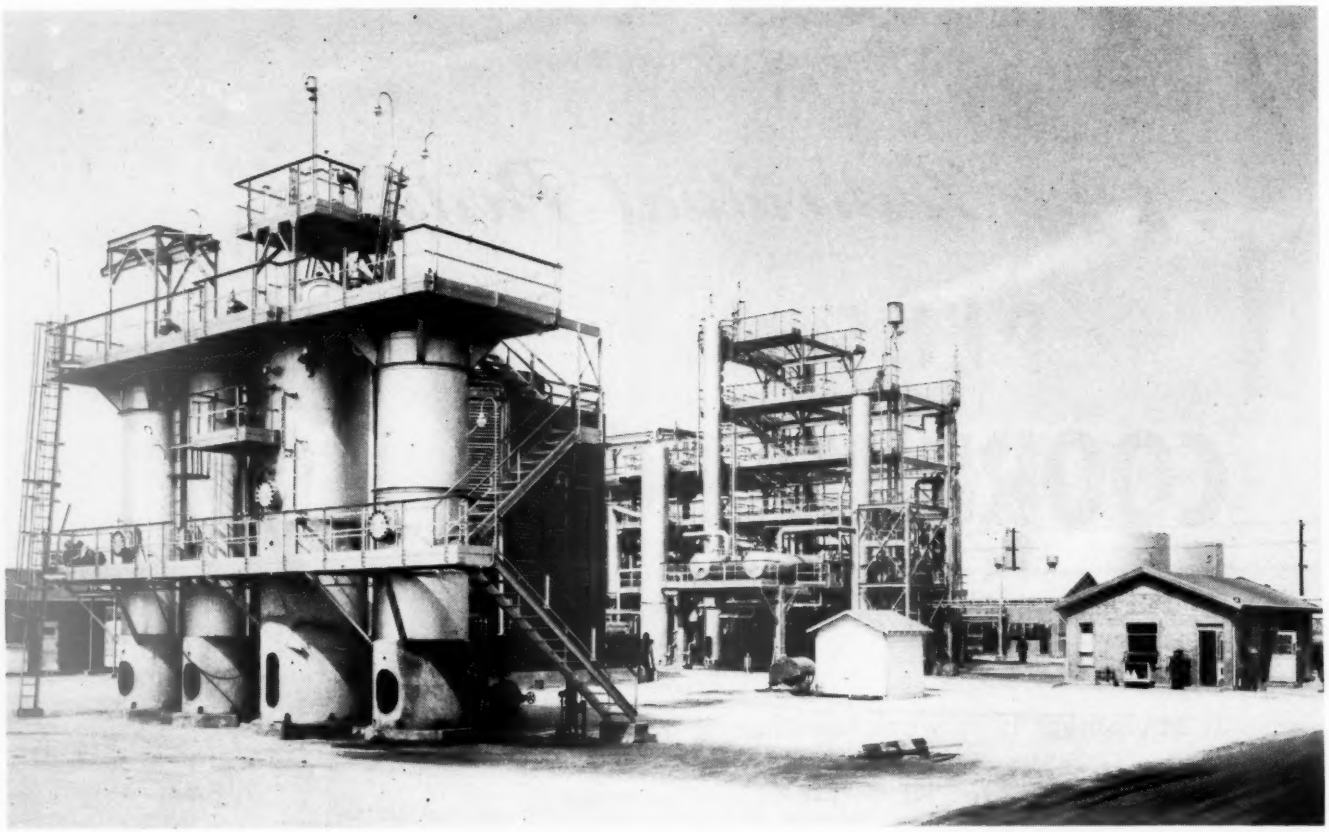




Towers in the foreground from right to left are: Sand filter, vacuum deaerator, calcium chloride driers No. 1 and No. 2. Back of these is a section of mechanical draft cooling tower. Next is central structure of the unit, then compressor house and control house. Tanks in the background are shipping tanks for finished products.

SO_2 extraction unit complete at Torrance

S. W. DICKEY, General Petroleum Corporation

With the termination of the recent war civilian demands for high quality petroleum products rose rapidly, creating a need for expansion activities within the refining industry. In order to meet requirements for superior grades of diesel oil and kerosine the General Petroleum Corporation commissioned the E. B. Badger and Sons Company of Boston to design and construct an SO_2 extraction (Edeleanu) plant capable of producing 50 cetane diesel oil at a charge rate of 5000 bbl per day with an SO_2 contact rate of 125 per cent or 6250 bbl per day. The unit was also designed to process kerosine at 5000 bbl per day rate and naphtha at 4100 bbl per day. After a period of careful collaboration between Badger and General Petroleum engineers, the plans were drawn up, completion of which was followed by construction preliminaries. Due to uncertainties in material shipments at that time it was decided to delay actual construction activities until 90 per cent of the equipment had been delivered to the site. When this had been accomplished, construction was begun and erection of the plant was pursued with excellent speed and efficiency, requiring an elapsed time of eight months to complete the job.

● **Process.** The Edeleanu process is based on the selective solvent principle employing liquid sulphur dioxide as the extraction agent. Essential features include a treating tower for contact of oil and SO_2, evaporator systems for recovery of SO_2 from raffinate and extract steams, facilities for continuously drying the SO_2, and a filter and deaerator system for removing moisture and air from the charge oil. A refrigeration system must also be included due to the necessity of maintaining a low treating temperature. Liquid SO_2 has the property of extracting compounds of high carbon to hydrogen ratio such as aromatics and olefins. Removal of these compounds is desirable because their presence causes a diesel oil to have a low cetane number and impairs the burning qualities of a kerosine. Also, compounds containing sulphur, nitrogen, and oxygen are removed, which further improves product qualities.

Oil and SO_2 continuously enter the treating tower where they are intimately contacted and the compounds mentioned are extracted. At the low temperature maintained for treatment the SO_2 is not miscible with the paraffinic type of hydrocarbons and the SO_2-extract phase forms a bottom layer due to its greater density. The extract solution is then sent to a series of evaporators to recover SO_2; and

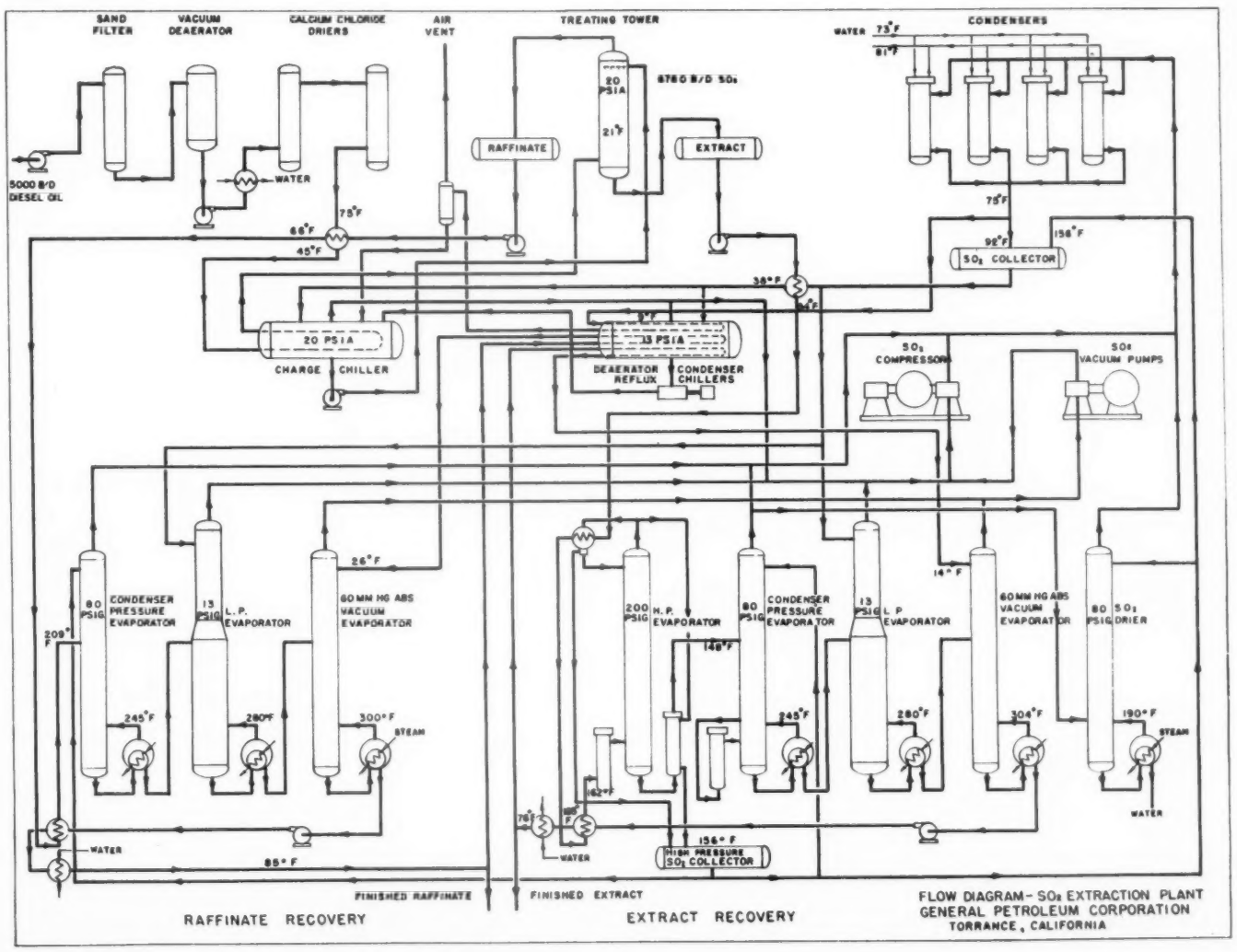
the raffinate, containing a small amount of SO_2, is treated in a similar manner. Degree of extraction is dependent upon the ratio of SO_2 to oil, temperature of treatment, and intimacy of contact between the two mediums. An increase in SO_2 to oil ratio will result in a greater degree of extraction, which means a higher quality raffinate at a reduced percentage yield. In all cases care must be taken to avoid the formation of a single phase, which would result from the treating temperature being too high or the SO_2 contact ratio being too low. Importance of treating at a low temperature is evident, but the level to which the temperature can be reduced is controlled by the pour point of the oil.

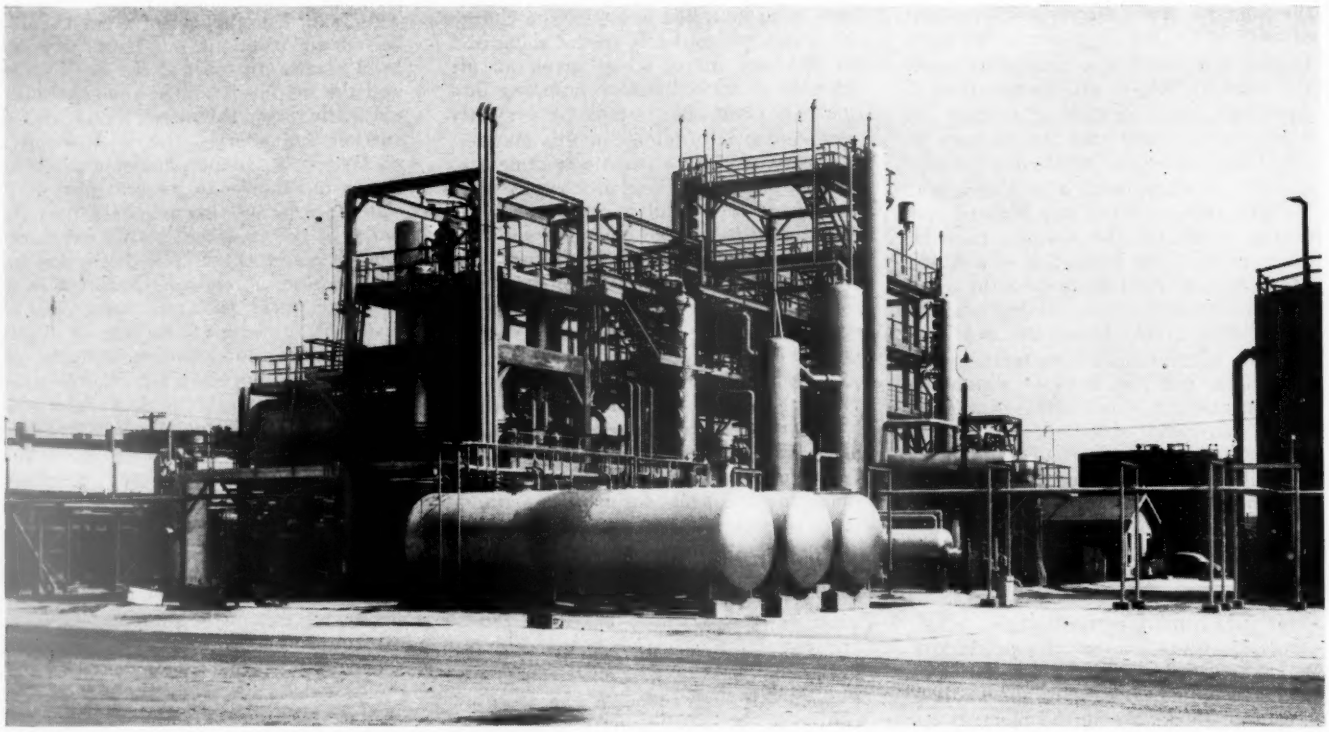
● **Plant description.** A description of the flow through the unit can best be accomplished by reference to the accompanying diagram. This drawing shows conditions of temperature and pressure at control points in the system when producing 50 cetane automotive diesel. Operating conditions for both 50 cetane diesel and kerosine production are shown in Table 1 and yields and properties of the two commodities are given in Table 2.

Charge stocks are stored in tanks remotely situated with respect to the SO_2 unit but convenient for receiving products cut on the crude units. The stocks are then charged to the SO_2 plant by pumps situated at these tanks. Extreme care must be taken to assure the charge stock being completely free of water and to this end diesel oil is given an air blowing treatment before pumping into the SO_2 plant charge tank. A perfectly clear stock is obtained in this manner. Kerosine is given a caustic treatment to extract naphthenic acid as it comes from the crude units and a short period of settling in the charge tanks is a satisfactory means of drying this stock. Naphthenic acid is not removed from the diesel oil ahead of the SO_2 treatment because of the difficulty of eliminating the resultant cloud. Therefore, the naphthenics are present during treatment and concentrate in the extract product from which they are recovered by a caustic wash. The naphthenic acids are removed from these stocks for the purpose of obtaining the acids for further refining and subsequent marketing.

Further feed drying facilities are situated within the boundaries of the SO_2 plant. The feed passes first through a sand filter, which is for the purpose of removing any suspended droplets of water entering with the charge stock. Presence of such suspended moisture is very rare because of the elaborate precautions taken to dry the stock. An alarm has been installed in the bottom of this vessel to sound warning if a large amount of water should accumulate. A vacuum deaerator is next in the order of flow. This is for the purpose of removing dissolved air from the oil. High and low level alarms are part of the equipment, and the oil level is held constant automatically. From this vessel a pump takes suction and charges the oil through a cooler to two calcium chloride driers in series and thence to the unit proper. A water alarm has been installed at the outlet of the cooler as additional safety against water entry. The driers are for the purpose of removing final traces of moisture from the feed and can be operated in series, parallel, or singly although the usual flow is in series. At present, for purposes of the test, the flow is up through the first drier and down through the second. It is believed that upflow prevents packing of the calcium chloride granules, but it is advantageous to operate the second drier downflow to prevent carryover of the drying agent into the unit. The filter and driers are frequently checked to remove water from the system and periodic inspections of the driers are necessary to determine the rate of calcium chloride usage. After a period of four months, the first drier had shown a loss of one-half the original calcium chloride content, which amounted to a usage of 12.5 lb per 1000 bbl.

From the drying system the charge then passes through heat exchange with cold raffinate and through the tubes





Closer view of central structure shows SO_2 storage tanks, one of the four SO_2 condensers, SO_2 drying tower, and extract evaporators.

in the charge chiller to the bottom of the treating tower. The charge chiller shell contains liquid SO_2 cooled by autorefrigeration, which is dependent upon vaporization to the SO_2 compressor suctions. Liquid SO_2 is fed to the charge chiller from the main collector, passing through heat exchange with cold extract solution enroute. SO_2 is then pumped from the charge chiller to the treating tower, entering at the top through a distributing ring and passing down through a section packed with 1-¾-in. Raschig rings. Contact is thus made as SO_2 flows downward through the oil, extract solution settling out at the bottom of the tower and raffinate solution passing over the top. Flow of extract solution from the tower is regulated by an interface level controller that operates on the gravity differential between raffinate and extract solutions. When producing 50 cetane automotive diesel oil, the extract solution contains 84 per cent (wt.) SO_2 and the raffinate solution 15 per cent (wt.) SO_2.

Raffinate and extract solutions collect in their respective accumulators from which they are sent to evaporators to recover SO_2. Three of these evaporators are used for processing raffinate solution, and four are used for extract. Both systems employ a condenser pressure evaporator, low pressure evaporator, and vacuum evaporator, but the extract system also uses a high pressure evaporator. Reboilers incorporate temperature and level controllers and are operated on 175-psi steam. Advantage is taken of the pressure differential between each tower to transfer liquid through the system instead of using pumps. Extract is pumped from the accumulator at the treating tower through heat exchange with SO_2 feed followed by heat exchange with SO_2 vapor from the high pressure evaporator and next with hot extract from the vacuum evaporator. Final heat adjustment before entering the high pressure evaporator is made by a heater operating on 10 psi exhaust steam. The heat applied at this point is controlled automatically to hold a 200 psig pressure in the vapor of the high pressure tower. Vapor from the high pressure tower is condensed by heat exchange with incoming extract solution and with bottoms from this tower, which have cooled by flash to the 80 psi pressure of the condenser pressure tower. A portion of the SO_2 liquid formed by the vapor heat exchange with incoming extract solution is used for reflux to the high pressure tower. Excess liquid from this source plus that from the condenser pressure feed exchanger is accumulated in the high pressure SO_2 collector and used for reflux to the two condenser pressure evaporators and the SO_2 drier. Excess SO_2 in the high pressure collector is transferred to the main collector by a level controller. Extract next flows on level control to the condenser pressure evaporator, which operates at sufficient pressure to condense the overhead SO_2 vapors, joined by vapors from the raffinate condenser pressure tower, at the cooling water temperature. A portion of the vapor is diverted by means of a remotely controlled butterfly valve to provide feed vapor for the SO_2 drier.

The extract low pressure evaporator takes its feed from the condenser pressure reboiler and operates at compressor suction pressure, which is on automatic control. Vapors from the raffinate low pressure evaporator join this line. The low pressure evaporators are supplied reflux from the main SO_2 collector. Extract next flows to the vacuum evaporator where final traces of SO_2 are removed. Vapor from this tower is joined by vapor from the raffinate vacuum evaporator enroute to suction of the vacuum pumps. These pumps discharge into the suction of the SO_2 compressors along with vapors from the deaerator condenser, charge chiller, and low pressure evaporators. Discharge from the SO_2 compressors enters the condenser pressure vapor line, which conducts vapors into the condensers. Liquid SO_2 from the condensers is then returned to the main collector to be used again for circulation in the process. The vacuum

TABLE 1. Operating data.

	50 cetane diesel oil	Kerosine
Charge rate, bbl/day	5000	4550
SO_2 rate, bbl/day	6750	7300
SO_2 contact ratio, per cent	135	160
Temperatures, F		
Treating tower	21	8
Charge chiller (shell)	27	14
Deaerator condenser (shell)	9	10
Main SO_2 collector	92	95
High pressure SO_2 collector	156	156
Extract evaporators		
Condenser pressure reboiler	245	234
Low pressure reboiler	280	280
Vacuum reboiler	304	306
Raffinate evaporators		
Condenser pressure reboiler	245	235
Low pressure reboiler	280	280
Vacuum reboiler	300	304
Pressures		
Charge chiller, psia	20	15
Deaerator condenser, psia	13	13
Treating tower top, psia	20	15
Extract high pressure evaporator, psig	200	200
Condenser pressure line, psig	80	80
Low pressure line, psia	13	13
Vacuum evaporator line, MM Hg abs	60	190

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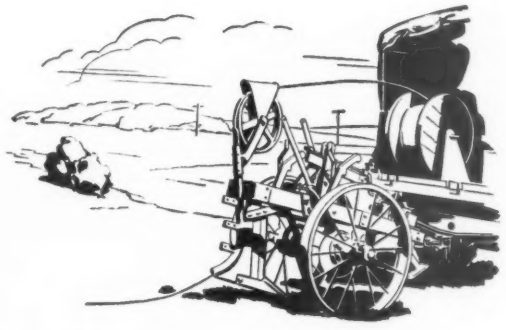

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TABLE 2. Yields and properties.

50 cetane diesel oil

	Charge	Extract	Raffinate
Volume per cent based on charge	100.0	25.0	75.0
Cetane number	40.0		50.0
Color—Union	3	6	1—
Flash point, F	180	180	180
Viscosity—SU/100	35	35	35
Water and sediment	0.0		0.0
Pour, F	—30		—15
Sulphur, per cent	0.34	1.25	0.09
Conradson carbon in 10 per cent bottoms	0.04	0.22	0.02
Aromatics and unsaturates	24	78	3
Aniline point, F	139.6	13.9*	169.5
Gravity, API	32.8	20.7	38.2
Distillation			
Initial	390	396	394
5 per cent	434	434	436
10 per cent	446	444	446
20 per cent	458	457	458
30 per cent	467	467	469
40 per cent	477	478	480
50 per cent	489	491	493
60 per cent	503	504	507
70 per cent	519	519	523
80 per cent	539	538	542
90 per cent	566	564	567
End point	616	628	614
Recovery	99	99	99

Kerosine

	Charge	Extract	Raffinate	Acid treated raffinate
Volume per cent based on charge	100.0	23.5	76.5	
Color, Saybolt	14		30+	30+
Color stability, Saybolt			30+	30+
Color, Union		1½		
Flash point, F	140	144	134	
Thermal viscosity	355	335	385	385
Sulphur	0.19	1.02	0.05	0.03
Conradson carbon in 10 per cent bottoms	0.02	0.05	0.006	0.001
Aromatics and unsaturates, per cent	18	75.0	2.0	1.0
Aniline point, F	128.8	16.9*	156.0	156.4
Smoke point	18		27	27
72-hr burning test			Failed	Good
Gravity, API	38.4	26.8	42.5	42.4
Distillation				
In	347	345	340	340
5 per cent	370	367	365	366
10 per cent	376	376	376	377
20 per cent	389	391	390	391
30 per cent	401	403	400	403
40 per cent	412	414	411	413
50 per cent	422	425	422	423
60 per cent	432	435	431	432
70 per cent	441	445	441	441
80 per cent	454	458	453	453
90 per cent	467	473	468	468
End point	500	509	499	500
Recovery	99	99	99	99

*Calculated.

evaporators are supplied reflux from finished raffinate and extract streams, respectively, which have been chilled by passing through tube bundles in the deaerator condenser. Finally, extract is pumped from the vacuum reboiler through heat exchange with incoming extract solution, followed by a cooler, and then passed through a caustic treating shell and into storage.

Raffinate solution is pumped from its accumulator through heat exchange with incoming oil charge, then through heat exchange with hot oil from the raffinate vacuum evaporator. It next enters the raffinate condenser pressure evaporator and passes through the series of evaporators in the manner described for the extract system. Oil from the raffinate vacuum reboiler exchanges heat with incoming raffinate solution, is further cooled by a water cooler, and pumped to storage.

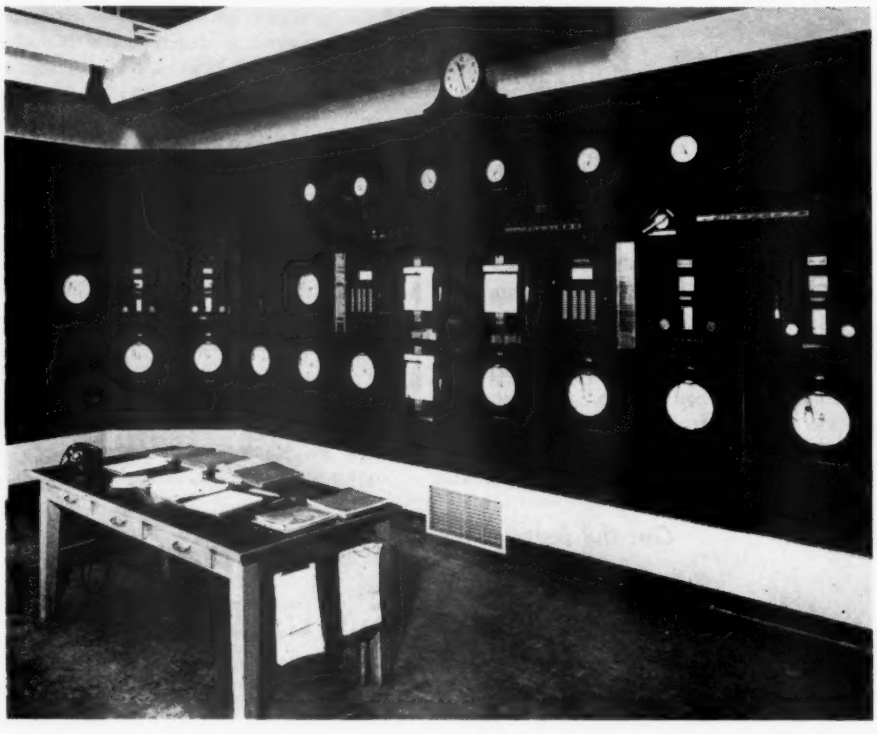
Extract and raffinate vacuum evaporators are operated in a manner to yield products completely free of SO_2. To do this it is necessary to operate the vacuum reboilers at temperatures sufficient to boil the light front ends of the oil as an aid in stripping out SO_2. The temperature is fairly critical because too high a temperature will drive oil into the vacuum vapor trap and too low a temperature will permit the presence of SO_2 in the product. A 3-ft 6-in. by 28-ft steel tower is used for air blowing the raffinate to remove the SO_2 when it appears in the stock during periods of upset. This tower has been fitted with five bubble trays and is connected to permit oil to flow down from the top against a stream of air rising from an inlet at the bottom. An air rate of 25,000 cu ft per hr will remove the SO_2 from a diesel raffinate containing up to 50 ppm. If the SO_2 content of the raffinate should exceed the capacity of the air blowing tower, the stream can be treated in a horizontal shell containing an ammonia solution. This treatment yields a cloudy product that requires prolonged settling to clarify and, consequently, is used only during emergencies.

● **Deaeration.** A small amount of air enters the system occasionally and accumulates in the SO_2 vapor sections operating at condenser pressure. This air must be held at a low quantity in order to maintain condenser pressures within practical limits. Removal is effected by means of a line connected to the condenser outlet. This vent gas passes through the deaerator condenser and enters a small pot to permit liquid SO_2 to drop out and be sent to the charge chiller by a level controller. Air is released from this pot by means of a motor valve operated remotely from the control house.

The deaerator condenser shell receives liquid SO_2 from a branch in the line feeding the charge chiller. A layer of SO_2 is held by level control in this vessel and is maintained at a low temperature by being in equilibrium with vapor at reduced pressure connected directly to compressor suction. This temperature, usually about 10 F, is normally lower than that of the charge chiller because vapors from the latter vessel pass through a motor valve before entering compressor suction and are held at a higher absolute pressure. Liquid levels in the charge chiller, deaerator condenser, and extract solution accumulator are indicated by the use of an insulated vertical column with horizontal plugs protruding through the insulation at uniform intervals. This column is attached to the vessel at top and bottom in the manner of a gauge glass, and liquid SO_2 seeking its level in the column will chill the plugs causing them to frost and exhibit a visual indication of the liquid level within the shell. Liquid SO_2 is continually pumped from the deaerator condenser shell into the charge chiller to prevent any increase in the concentration of water due to vaporization of SO_2. Air content of the vapor above the liquid in the main SO_2 collector is continuously recorded in the control house. This device operates from an instrument that transmits the differential pressure between the vapor pressure of pure SO_2 at the temperature of the main collector and the actual pressure in the main collector. This differential represents the air content of the system and is recorded in pounds.

● **SO_2 drying.** Despite precautions taken to dry the charge oil stream a small amount of water enters from this source, usually at a concentration of about 100 ppm. Moisture also enters the

SO_2 plant control room.



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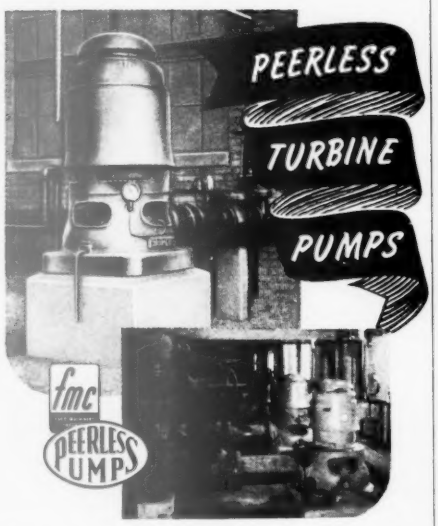

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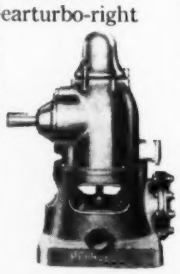

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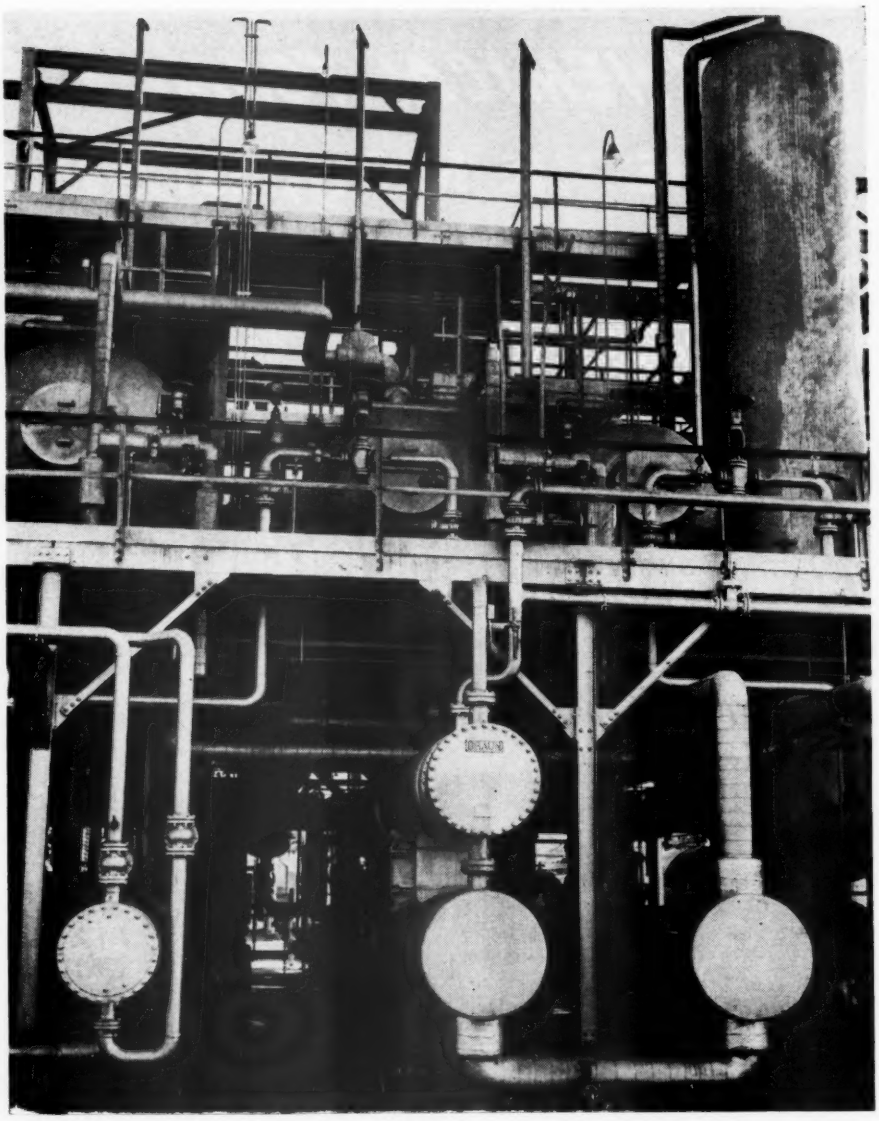

Closeup of cooling and treating section. On upper deck, left to right are charge chiller (a refrigeration vessel), deaerator condenser (another refrigeration vessel) raffinate solution accumulator, and treating tower. This tower extends to the ground, but lower part does not show in picture because of deep shade.

system with the air that leaks in. This water is absorbed by the liquid SO_2 and would soon reach corrosive limits if it were not continuously removed. Drying is effected by use of a 26-ft fractionating tower. As was mentioned earlier, the drier is fed by diverting the SO_2 vapor stream from the condenser pressure line. SO_2 vapor enters the drier near the bottom above a short section packed with 1-in. Raschig rings. A comparatively high reflux rate is used, and the SO_2 vapor is fractionated out of the water and passes from the top of the drier into the condenser pressure vapor line. A level of water collects in the reboiler, which is held at a temperature sufficiently low to minimize vaporization of water. Water is drained to the sewer from the reboiler to hold the level within designated limits. Some SO_2 remains dissolved in the water, but the loss from this source is small.

This method of drying is very effective, resulting in a usual content of 0.03 per cent (wt.) in the liquid SO_2 feed to the system. This is quite low in view of the fact that the safe upper limit is considered to be 0.1 per cent (wt.). A simple method of test, similar to that used by other west coast refineries, is used in the plant by our operators to determine the water content of the SO_2. In conducting this test 500 cc of liquid SO_2 is measured into a liter flask fitted with a calibrated tip at the bottom. The SO_2 is permitted to evaporate, leaving the water behind in the tip where its volume can easily be measured and converted to per cent. The Karl Fischer method has been used by the laboratory to check the plant test, and conclusions drawn from these comparisons are that the plant test is sufficiently reliable for control.

● **Switching stocks.** Both diesel oil and kerosine stocks have been run in the unit to date, the process of switching from one stock to the other having been

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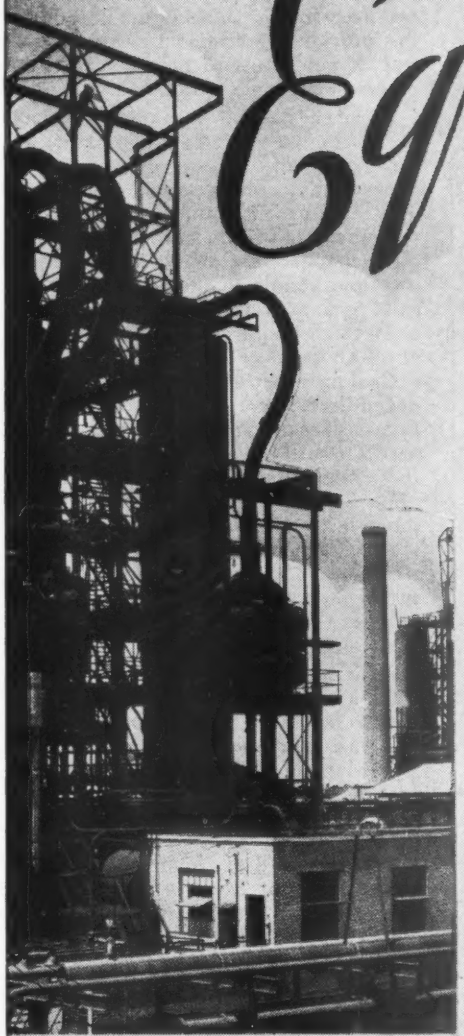

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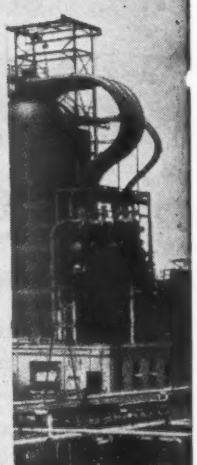

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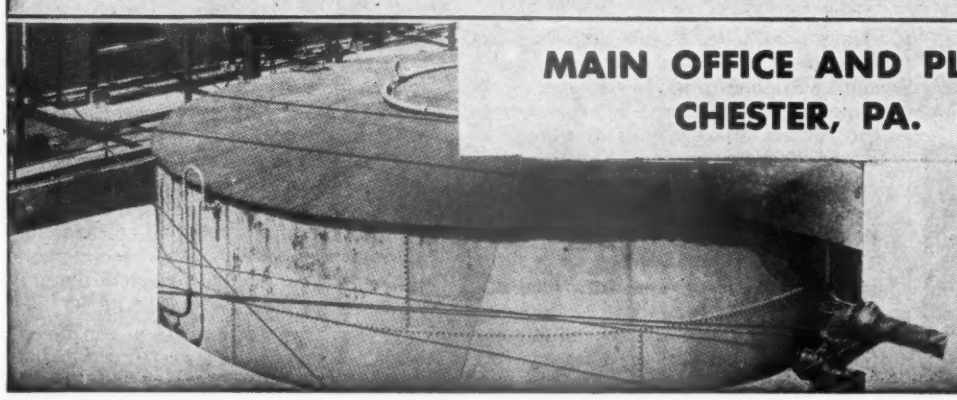

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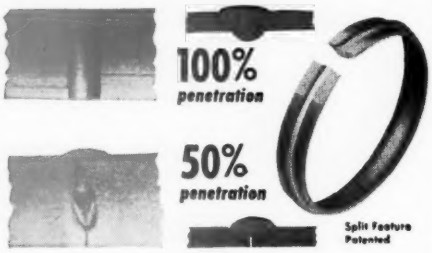

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effected smoothly. The chief operational changes to be made during such a switch are treating temperature, ratio of SO_2 contact, reboiler temperatures, and evaporator pressures. During these periods the unit is kept running at a uniform charge rate, and oil levels in the sand filter and vacuum deaerator are lowered. The new stock is then cut in and allowed to flow through the unit displacing the previous stock. A time schedule is employed to make control changes at various points in the system at the approximate moment the new stock appears. For example, in switching from diesel oil to kerosine the treating temperature should be reduced only after the diesel oil has been displaced to avoid getting close to the pour point of the diesel. At the time the kerosine reaches the vacuum reboilers the absolute pressure on this equipment must be increased from 60 mm Hg to 190 mm Hg to avoid flooding the towers. Similar considerations must be employed when going from kerosine to diesel stock. Diesel oil from the SO_2 plant is sent directly to storage ready for marketing, but kerosine raffinate requires further treatment. This product meets all specifications except the lamp test and is sent to the acid treating section of the refinery where it is given treatment with 98 per cent sulphuric acid. The lamp test is thus improved, and the finished product meets superior grade kerosine specifications.

● **Modern features.** The unit embodies latest features in SO_2 extraction plant design. In contrast to early plants using shell type evaporators, the General Petroleum unit uses fractionation towers equipped with bubble trays for the purpose of recovering SO_2 from product streams. SO_2 drying by use of concentrated sulphuric acid has been used by many plants since the inception of the process, but the more modern method of bubble tower drying is used in this plant because of its simplicity and trouble-free operation. Lines, shells, and towers in the plant are of carbon steel with the exception of the drier, lead lined upper section of the extract low pressure evaporator, and lead lined sump tank. All valves in service where SO_2 may be present are trimmed with stainless steel.

Evacuation lines are connected to vessels and lines in SO_2 service and lead to a manifold that permits suction through SO_2 compressors and vacuum pumps or entry into a sump tank that can be evacuated by means of an electric pump. Drain lines from vessels and lines are also connected to the sump tank, which can be drained to the sewer, or the contents can be transferred by pressure into the extract low pressure evaporator if dry oil or SO_2 is present. Flushing oil is used on glands of liquid SO_2 pumps, extract solution pumps, and raffinate solution pumps. Purge oil is applied to the SO_2 flow controller, treating tower interface level recorder, and drier feed rate recorder. Fischer and Porter rotameters coupled with indicating transmitters and receiver recorders are used for controlling reflux streams. This system has proved very satisfactory for handling small streams, which are likely to cover a wide range of rate due to changes in operating conditions. An emergency shutdown valve has been supplied that is operated from the control house and performs the function of shutting off the high pressure steam to all reboilers, closes off the make-up steam control to the exhaust steam line, opens the exhaust steam line to the atmosphere, and closes motor valves controlling oil and SO_2 charge rates. In the event of a sudden necessity for shutting the unit down this provides a convenient means of control. It is also useful for planned shutdowns under some conditions.

A cement pad has been placed around the entire base of the main structure for convenience of operation, maintenance work, and general cleanliness. The structure is equipped with ample stairways, walkways, and platforms, and all exchangers are positioned to permit the tube bundle to be removed onto a solid open area. Chain hoists are placed at strategic points to facilitate removal of tube bundles or other equipment.

Cooling water is supplied from an induced draft tower equipped with a temperature regulator operating a bypass on the return stream. Normally an electric driven pump is used for circulation of cooling water. A steam turbine-driven pump is always ready as a spare and will start automatically, simultaneously sounding an alarm, in the event of failure of the main pump.

Lines, vessels, and exchangers handling cold oil or SO_2 are insulated with from 2 in. to 4 in. of vegetable cork. Pumps in this service are insulated with a cork box filled with granulated cork and wax. Equipment in hot service is insulated with an 85 per cent magnesia coating. Towers, lines, and tanks are painted with aluminum. The control house interior is finished with green tile to a height of 4 ft around the walls. A section separate from the control board houses a wardrobe for operator's clothing. A sink and hot plate are included in this section, and a lavatory is in an adjacent room.

Initial start-up of the unit was accomplished in September, 1947. Equipment was first pressure tested with ojl and then subjected to drying procedures. The testing operations proved the plant to be the result of an excellent construction job, and drying of all vessels and lines was effected by circulation with hot oil followed by operation of the unit using isobutane in place of SO_2. The isobutane and oil were then removed; the entire unit was evacuated, and sufficient SO_2 was delivered, followed by the start of actual treating operations. Diesel oil was used as charge stock during these initial operations, and a product meeting all specifications was produced from the outset. The high quality of construction and success of operation are demonstrated by the low SO_2 usage in the unit to date. An average of 0.14 lb SO_2 per bbl of charge oil has been consumed, which is among the lowest in the industry. ★ ★ ★

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Offshore drilling methods and production problems

By GEORGE B. PARKS, Kerr-McGee Oil Industries, Inc.

EXCLUSIVE

ALTHOUGH much has been written about present methods and various possible means of drilling and producing wells in the open water of the Gulf of Mexico, it seems worthwhile at this time to summarize our limited experience and list some of the considerations involved. Despite the fact that drilling methods are in a developmental stage and production methods and techniques are in an experimental stage, the status of this offshore work is such that many operators are now forced to select a method that can be put into practice immediately. Some operators have assigned personnel to observe present activities to obtain the best possible first-hand data and experience for planning and executing their exploration and development programs.

● **Drilling.** Although numerous methods have been conceived and proposed as adaptable to Gulf of Mexico open water drilling, the risk inherent in any new method has reduced the number of those attempted and used effectively to (1) the piling platform and (2) the combination piling platform and floating barge methods. Drilling attempts with conventional type submersible barges in open water immediately offshore have not been successful to date. Their performance in partially protected water has indicated that they are not applicable as now constructed and used in inland water. One company, however, is considering adoption of this method to open water work, and others may be thinking about it.

The two methods now being used have been well described and illustrated by others. In the piling platform method, all drilling equipment and materials are mounted or stored on the platform. In those instances where the location is far from shore, quarters and other accommodations for personnel are also provided on the platform. One variation of this arrangement has been the quartering of personnel on a boat in inside water when the travel time from location to quarter boat made this arrangement feasible. This use of a quarter boat anchored in inside water eliminated vibration interference while crews were resting and reduced platform expense. Crews have been transferred by boat from land bases where travel distance would permit. Two companies are preparing to use the platform method in conjunction with quarters on a floating barge. The floating barge will also provide additional storage room.

The platform method generally requires expensive platforms as large as 200 ft by 100 ft. In the present platform and floating barge method, pipe racks, mud circulating pumps, and mixing pumps, reserve and active wet mud pits, dry mud and cement storage, crew quarters, and other auxiliary drilling and service equipment have been placed on the floating barge. A small platform about 45 ft by 80 ft is used in conjunction with the barge and supports the derrick, hoisting equipment, emergency standby pump and mud pit, shale shaker, rotary table, and other drilling tools.

The platform-barge method has been used by Kerr-McGee Oil Industries, Inc., and the Magnolia Petroleum Company and is in use now by these companies. There are minor differences in arrangement, such as location of the well logging, perforating, and coring unit on the platform over the engine shed in lieu of placement on the floating barge, and some differences in size of platform mud tank, and the design of walkway chute between pipe racks. With one major exception, these methods are almost identical. This exception is the anchorage system. Kerr-McGee Oil Industries, Inc., uses five marine-type anchors, three out from the bow and two from the stern. A stern chain connects the barge to a wood bumper piling cluster. The five anchors are attached to the barge at gasoline-powered winch drums or at electrically-powered capstans. Magnolia has fixed anchorage with steel H-beams driven into the ocean floor, giving a rigid anchorage system. Magnolia's drilling barge now has three bow anchors and four stern anchors. All are of the fixed type attached to a gasoline-powered winch drum or electric powered capstan. Experience on the Magnolia location has made necessary the addition of the last two of the four stern fixed anchorages. Magnolia has also found it necessary to use 1¼-in. wire line for connection to the anchorages. Kerr-McGee's combination method developed the necessity for chain connection to the dolphin cluster. Magnolia has used their barge-platform combination in 30 ft of water, and Kerr-McGee has used theirs in 18 ft and 10 ft of water.

The primary problem in using the barge-platform method is designing an anchorage that will keep the barge at the platform or close enough to circulate mud and handle tubular goods. Other problems are: (1) Placing conventional drilling equipment in the most suitable places and (2) deciding how much investment is desired in accommodations and conveniences above those required by the United States Coast Guard. It is necessary to do considerable planning in equipment placement to minimize barge conversion costs and yet be consistent with good operations from a seaworthy standpoint as well as for drilling operations. Equipment and storage location, of course, affects the motion of the barge in the sea. The curves of form or performance curves for the barge must be kept within a stable safe range.

The barge and platform combination is believed to involve more risk than the large platform alone, the risk appears to be proportional to the depth of water. This opinion is based on personal observations and the consensus of those spending considerable time in the open Gulf. Although the ratio of the number of days worked to the total number of days spent on a well, as an index of efficiency, has been more than 90 per cent on each location using this method, there is, even with the most careful attention to weather forecasting, nothing the operator can do to guarantee that lost time will not occur while running a string of casing, or while a deep test is kicking after encountering a salt water flow or a high pressure gas stratum.

It is also more difficult and expensive to "skid over," if the hole is junked on a small platform. The working time in the efficiency index calculations sometimes includes a number of days that the barge is away from the platform, because the crews were able to work at rigging up, mounting wellhead connections while awaiting cement, or drilling surface hole. Magnolia drilled most of the 2500-ft surface hole with the barge away from the platform on its block 72 well in the Ship Shoal area, and Kerr-McGee was forced to circulate with the barge away from the platform while drilling the surface hole on its block 32 Field, discovery well. Drilling below surface pipe on these wildcat tests has been considered inadvisable while the barge was away from the platform.

The number of rig days that the barge will be away from the platform will vary indirectly with the depth of the water. Improvements in the methods of anchorage and operation during the period that the combination method has been in use, however, makes it difficult to analyze the effects of water depth.

Present experience has shown the best weather period, or the greatest density of good working days, to be in the summer during and preceding the hurricane season. It will be necessary at times to move the drilling barge from the platform, and, in some instances, to abandon work when tropical disturbances in the gulf move inland over a large part of the coast. Effects have been felt off the Louisiana coast from disturbances

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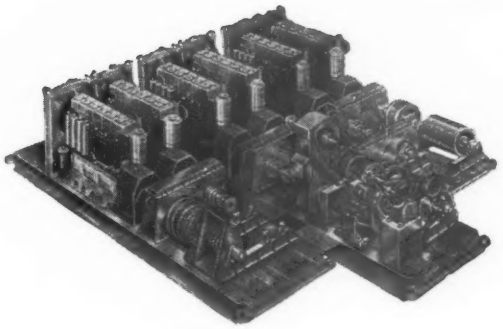

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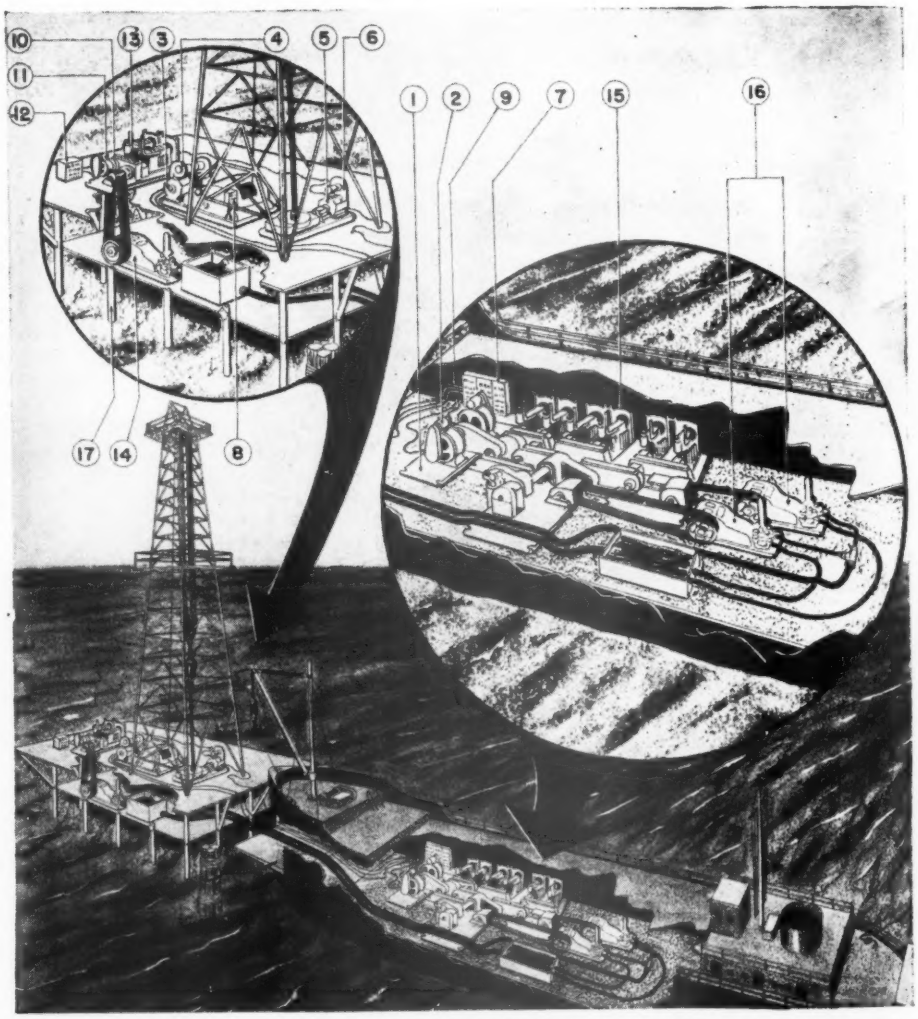

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4. 3600 CFM 3½" pressure blower driven by 5 HP, 1750 RPM, 125 volt explosion proof DC motor.
5. General Electric 250 HP continuous, 75 degree C rise, 425 volts, 900 RPM rotary table motor. 2900 ft/# maximum stalled torque. 1425 RPM maximum safe speed.
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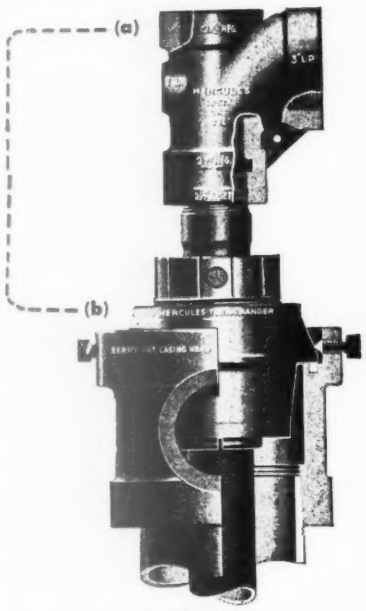

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that moved inland from Florida to Tampico, Mexico. When hurricanes have moved inland within the range just mentioned, it has stopped pile driving and platform building in nearly all cases regardless of the intensity.

Drilling operations can be carried on in considerably rougher weather than platform construction. The closer the center of the disturbance, however, the greater the interruption of work, and, in the event that a storm moves inland near an operation, it is necessary to abandon all work and move the floating plant far inland to protected water as soon as possible regardless of the method used. Some observers minimize the additional risk in the combination method by arguing that the transfer of personnel, emergency supplies, and mud would not be possible on the platform method when a barge is away from its platform due to rough weather. It seems to the writer, however, that the hazards of transferring personnel and supplies are part of any open water method and that differences between the two methods are immaterial.

In the summer or during the hurricane season, the combination method requires that a tug boat be available upon short notice to move the drilling barge inland during tropical disturbances. Kerr-McGee drilled its deep test, Block 28 Well No. 1 Ship Shoal area, in 10 ft of water seven miles offshore without a tug boat during the winter months. It has been necessary to hire a tug boat only once this spring to position the barge. This well is now drilling below 13,000 ft.

The floating barges now in use are usually very stable and comfortable without much roll or motion. Comfortable quarters for personnel as well as safe working space for racking and handling pipe, electrical logging, perforating equipment, and other operational needs, are provided rather easily on these barges. Picking up or laying down tubular goods and the additional connection and rig up work required when moving barge to and from platform offer no serious problems, but are items that should be taken into account as they entail additional effort over and above the conventional methods available when platforms alone are used. With only a standby mud pump and a mud pump tank on the small platform in the combination method, it is apparent that most of the prime movers must be placed in the barge.

A large platform may be most desirable for directional drilling operations as the safest and most economical method. The average angle of deflection for Gulf Coast directional drilling is 14° to 15° from vertical. This high angle combined with the frequent need of drilling directionally to depths of about 9000 ft will certainly lend itself in some cases to the large multiple well platforms for flank well exploration and development on shallow structures and for all drilling on the deeper structures.[1]

1. "Practical Aspects of Directional Drilling," D. K. Weaver. *API Drilling and Production Practices, 1946.*

Perhaps the exploration and development problems in the open Gulf will lead to the development of methods and techniques for using larger deflection angles at greater depths. The Creole field open water development is an example of this method of solution.

Kerr-McGee's State of Louisiana No. 2 in the Block 32 Ship Shoal area field will be a test to see what can be done in high angle deflection in shallow surface sands. Being drilled from the discovery well platform, it will have as its objective a 660-ft deviation at a depth of about 1800-ft, making it necessary to build and carry a 30° angle.

To sum up, it seems that where reasonable risk is assured the economy of the combination method makes it desirable, especially when the drilling of a series of wells from a large platform is impracticable. When data available to the operator indicate that a series of wells might be drilled from a large platform, the choice may be difficult. A series of wells from a large platform might enable an operator to develop a large part of a structure, or effectively condemn the whole structure. It is evident that each method has certain advantages. The choice depends on the depth of the water, the kind and depth of the well or wells, the type of the geologic structure, and other conditions that might exist. The writer believes the fixed-type anchorage to be preferable for the combination method, and that its use will extend the application of the combination method by reducing the hazards involved.

● **Production.** With the exception of the Creole field, immediately offshore, in Cameron Parish, there has been no appreciable oil production from the open, unprotected Gulf of Mexico waters. About 10,000 bbl of crude oil has been produced from wells out of sight of land, and there is little production experience to review. The testing of the first producing well in the open Gulf and the plans for producing it have brought to light problems that will have to be met by other operators that find oil in this area. The most difficult problem to select is the most feasible means of moving the oil from wellhead to inside storage or market.

● **Pipe line.** Where production is immediately offshore, as in the case of the Creole field, the problem of movement is solved by laying a pipe line. In cases such as Kerr-McGee's Block 32 Field discovery well, further development of the field and testing of the wells are necessary to prove that the reserves will justify an expensive pipe line investment. The fact that the line will be through one of the most prolific and heavily worked shrimping areas makes it necessary to bury the line about 6 ft below the ocean floor. This problem may be difficult and expensive to solve. Building a gathering system and pumping station on an open Gulf platform will entail the heavy costs associated with all permanent open water structures. The encountering of various reservoirs and oil gravities as are present in piercement type dome development will in-

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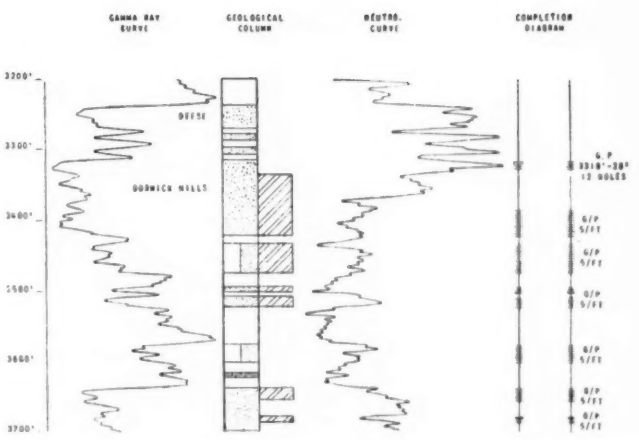

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crease the outside pumping station requirements and problems, especially where outside storage tanks or batteries are not available.

● **Barges and tankers.** Transporting oil produced when testing wells in the initial stages of production must be done usually by barge, especially in the far offshore wells, for the reasons mentioned above, and because tankers are so expensive that they cannot be used when oil well production volumes are small and the transportation unit must serve as a storage unit. Barges can supply storage room for testing and initial production operations. Fire hazards are thus reduced and large platforms do not have to be constructed for tank batteries.

The Block 32 Field discovery well was tested with a small 3,000-bbl oil barge. The test separator discharge was connected through a flowline hose to the barge. Barges are much more difficult to handle and tow offshore than in protected waters. They cannot be left tied to a platform unless a towboat is available to place the barge on an anchor when the weather produces a rough sea. In large ground swells a barge used for storage must be placed on an anchor near the rig so that it can swing clear of the platform when there is sufficient anchor line out to secure the barge.

It is evident that when barges are used for storage as well as transportation they will require considerable attention, probably much more than would be necessary if storage was available on a platform. Further experience will indicate whether the use of barges in open gulf waters as combination floating tank batteries and transportation units will be satisfactory.

Production of Kerr-McGee's discovery well off the coast of Terrebonne Parish was resumed in May with a 5700-bbl and a 2000-bbl barge. Floating plants such as barges or tanker must meet the American Bureau of Shipping and United States Coast Guard requirements for outside use. Conventional flat bottom oil barges must meet somewhat stricter structural requirements than for inland waterways. This should be taken into consideration in planning to move oil from offshore wells. Load line requirements gives less load capacity than for inside use. In some cases, minor or relatively inexpensive changes will bring conventional barges up to requirements, whereas in others, barges cannot be modified economically for outside use.

● **Inside and outside storage.** Fire hazards make undesirable the placing of storage tanks on well platforms and very little room is available on small platforms. Construction of tankage on platforms in the Gulf is, of course, quite expensive, but, in some locations where difficult and expensive conditions are encountered in pipe line installation, tankage on platforms in the Gulf with sufficient capacity to make barging or use of small tankers economical may be the proper solution. Although rough weather might make the handling of more than one barge unit difficult, single barges might be used to load at outside tankage while other barges are tied up at an inside point. This system is used in present barging practices in negotiating bad crossings in inland waterways. The use of inside storage makes it necessary to use oil meters in the field in conjunction with tank gauging at an inside point. When a pipe line is used, it appears that minimum outside tankage for a pumping station to an inside terminal and tank storage is the most satisfactory arrangement. Another scheme for outside tank storage that may prove applicable is the proposed method of sinking a conventional barge, or other vessel for storage, and holding it at rest on bottom with spuds or piles. As oil is produced, it displaces the water in the barge. The oil is then displaced with ocean water into transportation barge units. Similar arrangements are used in certain air field type fueling systems.

Submerged storage vessels might be designed to serve wells or offshore fields satisfactorily for a while, but leaks would probably be more difficult and expensive to repair than on platform-type storage tanks.

More experience is necessary to evaluate the methods proposed for storing and transporting crude oil. It appears from what consideration has been given the problem that, as with the drilling methods, there will be no panacea.

● **Acknowledgment.** Acknowledgment is herewith made to Kerr-McGee Oil Industries, Inc., for permission to publish this article.

* * *

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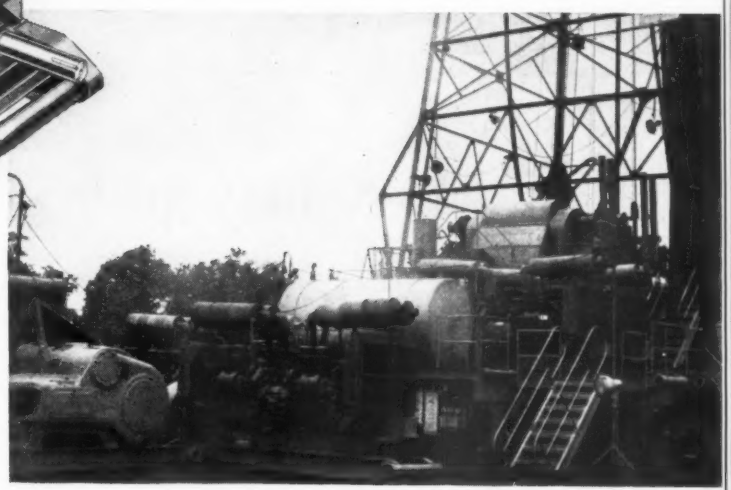

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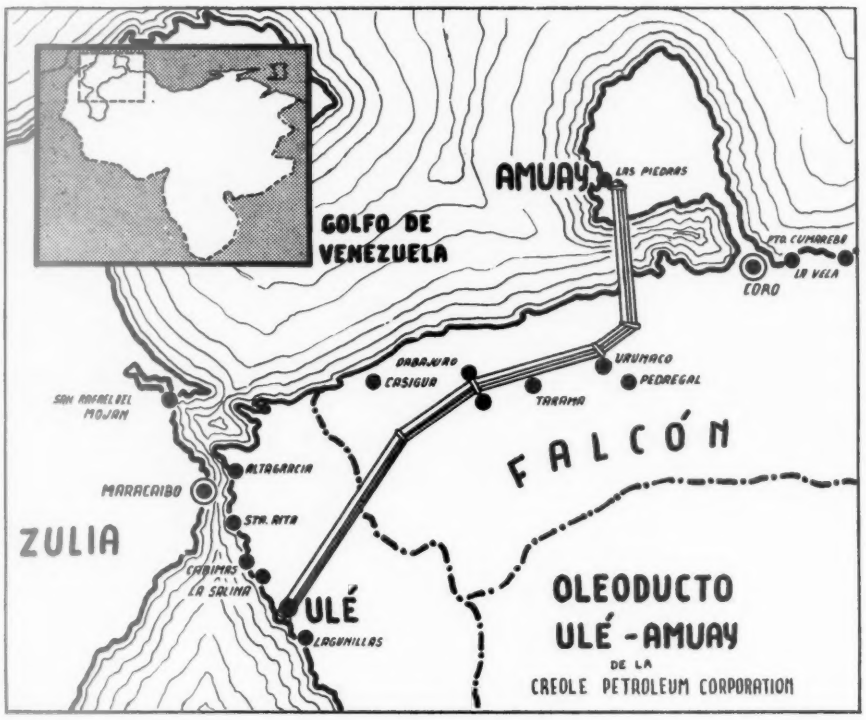

Ulé-Amuay pipe line pushes toward completion

WITHIN a matter of a few months Venezuela is to become the possessor of one of the world's most modern pipe lines, a 26-in. diam steel tube that will stretch from the eastern shore of Lake Maracaibo to the Paraguaná peninsula jutting out into the Caribbean.

The line is being built at a cost of Bs 110,000,000 by the Creole Petroleum Corporation.

Two fundamental economic facts are recognized in the construction of the line. On one hand are the vast oil resources of the Distrito Bolivar, in the state of Zulia. On the other the large new refinery Creole is rushing to completion at Amuay Bay, Paraguaná. The 231.6 kilometer crude oil line will constitute the vital link between them.

Construction began May 1, 1947, on the oil artery that, when completed, will carry vastly more liquid cargo than any other line in the country. The diameter of its ponderous sections vary from 24 to 26 in., thus making it the largest diameter pipe line so far built to carry oil.

Creole's pipe line engineers are proudest not of its record-breaking length nor of its unprecedented diameter, however. The project is the sum of its parts, they declare, and point to the line's multiple advances in pipe line technology that will make it the most up-to-date crude oil carrier in existence.

Prime purpose of the line is to pump crude oil from Creole's tank farm at Ulé, between La Salina and Lagunillas on Lake Maracaibo, across the states of Zulia and Falcón to the new refinery at Amuay. To reach Paraguaná the line will dip below the sandy bottom of the Golfete de Coro.

When the project is completed, from 300,000 to 325,000 bbl of oil per day will flow to the Amuay installations where the refinery will process up to 60,000 bbl daily into petroleum products. The remainder will be piped into storage tanks whence it will be pumped into ocean-going tankers bound for the world's oil markets.

Creole engineers plan to begin pumping oil through the line by December 1, 1948, if no out-of-the-ordinary obstacles are encountered. At first, it will carry only 200,000 bbl a day, but by the end of December, 1948, when the line and all its associate projects will be completed, it will be able to operate at capacity.

The company has contracted with the Williams Brothers Corporation to do the actual pipe laying. Construction is now progressing simultaneously from Ulé and Amuay toward midpoint at Debajuro.

Leaving Ulé the line runs in a northeasterly direction toward El Mene, in Falcón's Distrito Miranda. Passing north of El Mene, it comes close to Debajuro's southern outskirts. From there it swings north of Tarana and Urumaco, after which it goes in a northerly direction to the Golfete de Coro. Beyond the gulf crossing the line ends at Amuay Terminal.

A number of difficult problems are being encountered during construction. The large diameter pipe, with its extreme rigidity, has made it difficult for pipe laying crews to bend sections without damage. Stringing the 2-ton pipe joints together in itself has constituted a major problem.

Supplying materials to the central zone of the project near Debajuro also proved difficult in that some 32,000 tons of pipe and materials have had to be loaded on barges at Amuay and transshipped to be unloaded on the beach on the coast of the Gulf of Venezuela north of Debajuro.

Further headaches have been caused by the complete lack of all-weather roads at any point along the line, especially when huge trucks carrying 10 joints of pipe each were used to bring pipe to the right-of-way.

The principal question mark in the project, however, is laying pipe 1 meter below the bottom of the gulf. Technicians experienced in submarine lines anticipate choppy seas when the wind lashes the gulf's shallow waters. These may slow the progress of dredges scooping a trench in the ocean bottom.

At no point along the pipe line's route is the gulf deeper than 7 meters. The portion of the line buried under water will be made up of pipe of ½-in. wall thickness. It will be coated with a special protective covering to resist salt water corrosion.

On land the line will be laid through comparatively level country, with no extremes of altitude to complicate construction. The highest point along its route, in fact, is 139 meters above sea level.

The countryside is mostly covered with vegetation, some of a heavy tropical nature. The line crosses about 15 rivers, all subject to flash floods. These obstacles are being overcome through the erection of trestle-like bridges made of heavy pipe sections sunk into the ground or river bed and filled with concrete. The pipe line rests on these supports.

The 600-ft wide Zazarida River channel will be crossed by laying the pipe below the river bottom. The pipe will be double-coated and wrapped and then encased in a concrete-filled trench 6 ft below the river bottom. Elsewhere, the majority of its sections simply rest on the ground. Wherever it traverses marshy land or where it is buried underground, the pipe is given extra coatings of protective material.

An important phase in the project has been the clearing of a right-of-way 30 meters wide through the scrub brush and the forested portions of the Zulia and Falcón countryside. The line itself is be-

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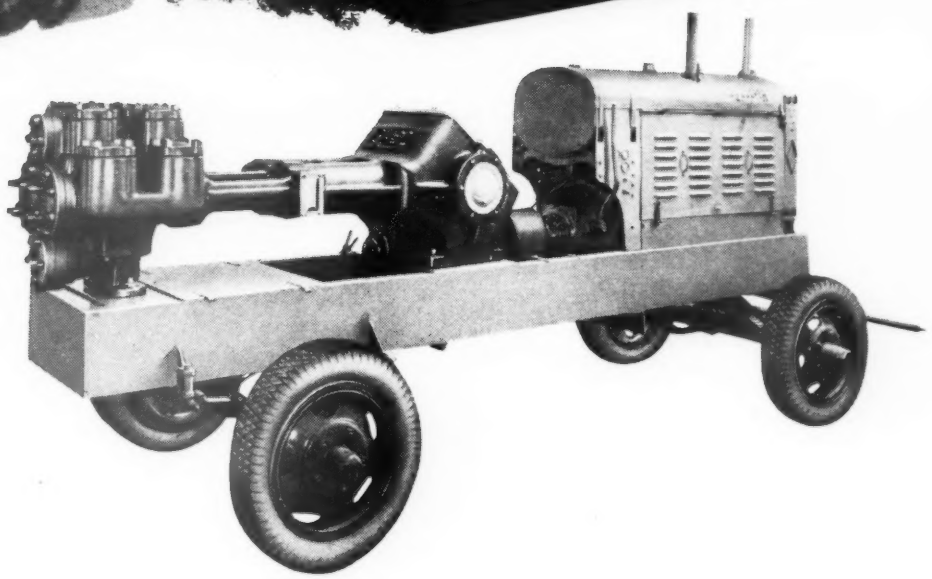

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ing laid 10 meters in from one side of the strip.

The barren swath cut through the fields leaves the pipe line easily visible for the careful scrutiny of company line patrols that daily inspect its entire length for leaks or damage. They are vital not only for the conservation of the oil but also for the protection of property along the right-of-way. If a leak is discovered, prompt measures are taken to prevent excessive leakage of oil that might damage adjoining land.

Complementing the patrols are the delicate instruments in the dispatchers' offices at the pumping stations. These flow and pressure gages register capacity and pressure drops such as those that could be caused by a leak. In this event the oil flow can be promptly halted by means of gate valves installed at regular intervals along the line. Sets of the valves will be installed at both ends of the water crossing, to be used in the event of submarine pipe line damage.

Specifications for the project call for Grade B API steel line pipe beveled for welding. The pipe is being manufactured by the National Tube Company, a subsidiary of the United States Steel Corporation. Pipe wall thicknesses vary from $\frac{3}{8}$ in. to $\frac{1}{2}$ in. according to the terrain and proximity to pumping stations. Pipe diameter varies from 24 to 26 in. in accordance with computations to maintain proper pressure and flow.

The Ulé-Amuay carrier will be the world's largest diameter oil pipe line—but only for a comparatively short time. Construction has begun on the 30-in. and 31-in. pipe line more than 1600 kilometers long from the fabulous oilfields of Saudi Arabia to the Mediterranean.

The formidable task of trucking the pipe into the virtually roadless districts of Venezuela, hoisting the sections into place, and then welding them together is only part of the job to be done.

Two pumping stations are being constructed, one at Ulé and a second one about 10 kilometers west of Debajuro. In addition, storage facilities have been built at Ulé, Debajuro, and at Amuay Terminal.

These stations in themselves are enterprises of considerable magnitude. The Ulé station is a concrete and steel building 90 meters long and 24 meters wide. It contains seven Worthington horizontal triplex double-acting reciprocating pumps driven by seven 940-hp Cooper-Bessemer 8-cylinder gas-diesel engines. Each is capable of pumping 50,000 bbl a day at a pressure of approximately 900 psi. The flow of oil through the line will be at about walking speed — 5.6 kilometers per hour ($3\frac{1}{2}$ mph).

Debajuro's installations are to be similar to those at Ulé. Both stations will have their own electric power generation. The Ulé plant will produce 350 kw, whereas the Debajuro plant will turn out 700 kw. Office buildings, employe housing, recreational facilities, and commissaries are planned for both.

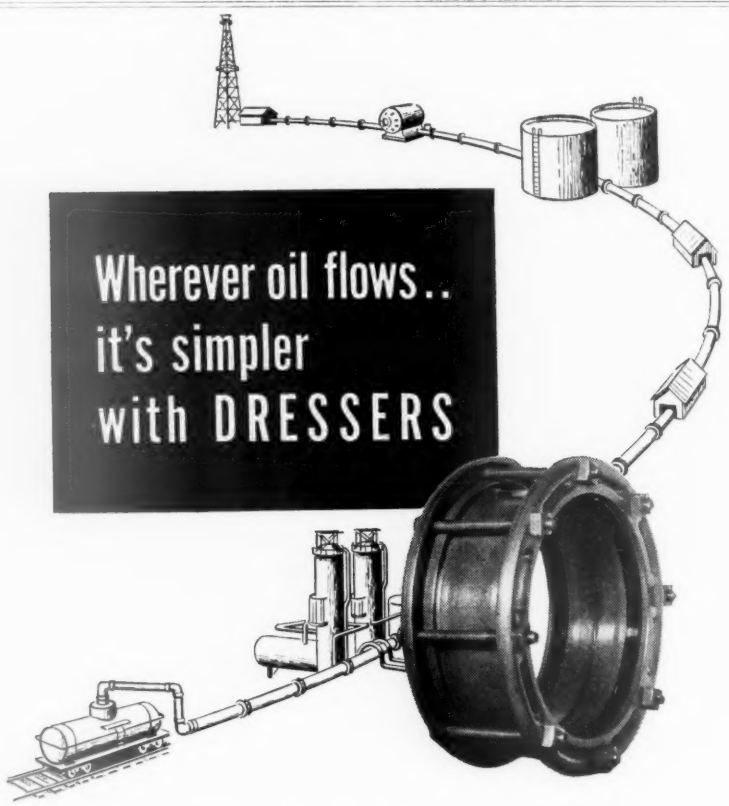
The established Creole tank farm at Ulé has been expanded with the construction of eight new 150-ft by 48-ft floating-roof type steel storage tanks, each having a capacity of 150,000 bbl. At Debajuro, three 120-ft by 48-ft cone-roof steel tanks are being erected, each capable of holding 96,000 bbl.

Sixteen tanks with a total capacity of 2,400,000 bbl have been completed at Amuay Terminal, where the incoming oil will be destined either for the refinery or for prompt export by tanker. Creole's available tankage space will thus be increased by 3,888,000 bbl when the pipe line project is completed. Creole (and partners) at present has tankage capacity of 14,711,860 bbl.

The nervous system of a pipe line is its communications system, an essential adjunct to safe, efficient carrier operation. The company is installing communications equipment never before used in Venezuela to link the two stations and Amuay Terminal. An elaborate radio network consisting of five voice channels in the VHF (very high frequency) range plus three radio teletype channels make up the system.

Construction of the pipe line, pumping stations, and storage tanks is expected to utilize the services of from 900 to 1000 men for a period of 12 to 18 months. Provisioning and transport of these workers poses a real supply problem.

After the system is fully operative a permanent force of 125 men will be



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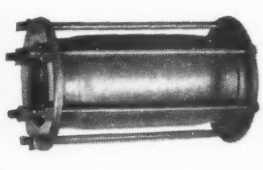

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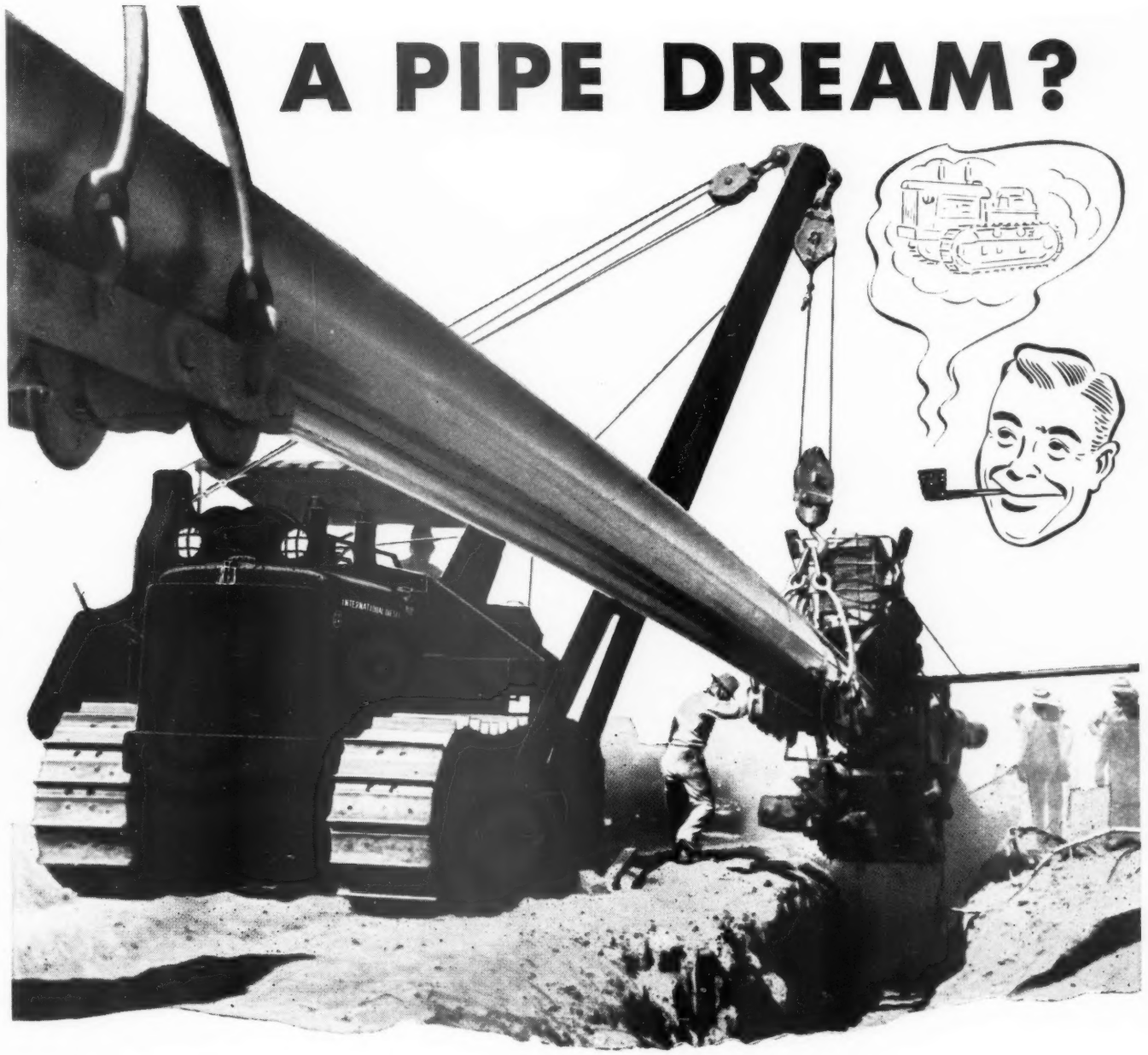

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needed to keep it going. Adequate housing for them and their families is being built at the three salient points on the system.

Venezuela and the oil industry will reap many benefits from the existence of the Ulé-Amuay pipe line. The most obvious of these is that the pipe line will make a going concern of the Amuay refinery, which it will serve as the principal raw material source, and the refinery, of course, will bring manifold blessings to the national economy.

Hence, the pipe line is under construction today because Creole economists figured that it would be the least expensive and most reliable way to carry lake oil to Amuay over a period of years. In the long run, they reasoned, Creole would have lower production costs. Venezuelan oil will be better able to compete with lower-priced crudes on the world oil market.

A second major advantage derived from the pipe line is that its existence guarantees an uninterrupted flow of oil to the Amuay refinery—a Venezuelan industry upon which the livelihood of thousands of Venezuelans will depend directly. Again, the line and refinery bring new and permanent development to heretofore neglected regions of the nation. Together they bring thousands of permanent jobs, sanitation, roads, agricultural and municipal improvements, and countless other benefits as by-products of their existence. The entire state of Falcón will profit from the elevated living standard accompanying establishment of an important segment of the oil industry in that region. It is interesting to speculate on how many permanent new jobs will ultimately be created in Falcón alone by the new refinery and pipe line system.

The pipe line is concrete evidence of Creole's confidence in the continuing productivity of the western oilfields. The company's considerable investment in the line is ample proof that the oil industry as well as the nation is deeply interested in wise exploitation and conservation of Venezuela's richest material resource.

A large part of the Bs 110,000,000 pipe line expenditure is ending up in the pockets of Venezuelan laborers, for labor costs bulk high in pipe line construction expenses. Additional thousands of bolivares are being paid to Venezeuelans for sand, gravel, lumber, and other materials used in the project.

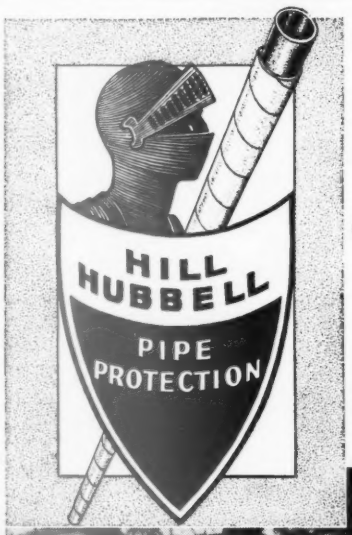
Pipe lines, though perhaps a novelty in Falcón, are of course nothing new for Venezuela. The oil industry has constructed approximately 1567 kilometers of lines in the country. Creole alone has completed 207 kilometers and shared in the construction of 357 kilometers more. Approximately 413 kilometers of new lines have recently been completed, not including the Ulé-Amuay project. The Socony-Vacuum Oil Company of Venezuela is now operating a 161-kilometer 12-in. line from the Guico field, in the Oficina area, to Chaure, close to Puerto La Cruz. Its capacity is approximately 50,000 bbl a day. The Texas Company has completed a 16-in. line from its Las Mercedes field 252 kilometers to Pamatacual, 2 kilometers east of Guanta. It is capable of delivering 60,000 bbl a day.

Now under construction is Creole's 16.8-kilometer line from Catia de la Mar to Nueva Caracas. The 8-in. line will carry refined petroleum products to consumers in the capital area.

The lines are of great value in the never-ceasing battle to keep production costs and prices at a minimum. Creole's need for a transport outlet for its lake oil forced expansion of its expensive tanker fleet carrying crude to Aruba to an overall capacity of 554,800 bbl a day by the end of 1947. In contrast, the new pipe line will carry 300,000 bbl a day.

It is a remarkable fact that pipe lines here and in other oil-producing countries carry a large part of the total freight moved by all types of transport, but still remain almost unknown to the general public. The lines are silent, unobtrusive carriers.

In the United States, for example, 224,000 kilometers of lines carry one-ninth of all the freight moved in the country and are the nation's third largest freight carrier. Equally startling figures can be cited for Venezuela. Creole's new pipe lines will transport 42,857 metric tons of oil per day—a single line. By contrast, the nation's premier port, La Guaira, currently handles an average of 46,000 metric tons of cargo per month. * * *



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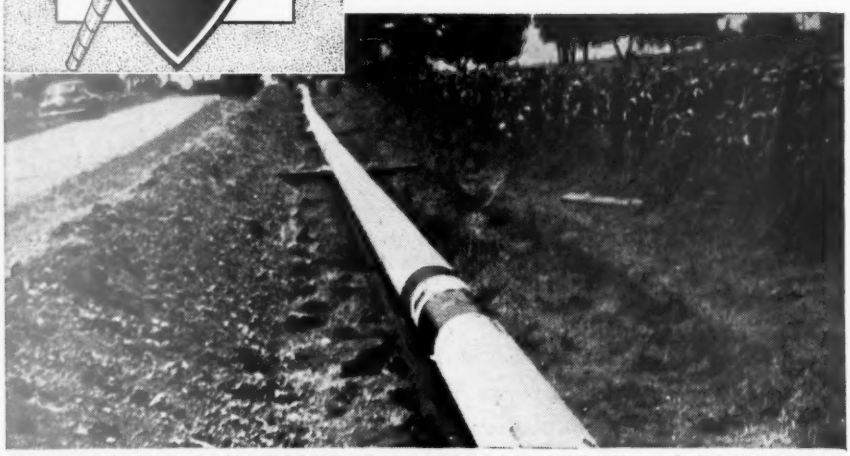

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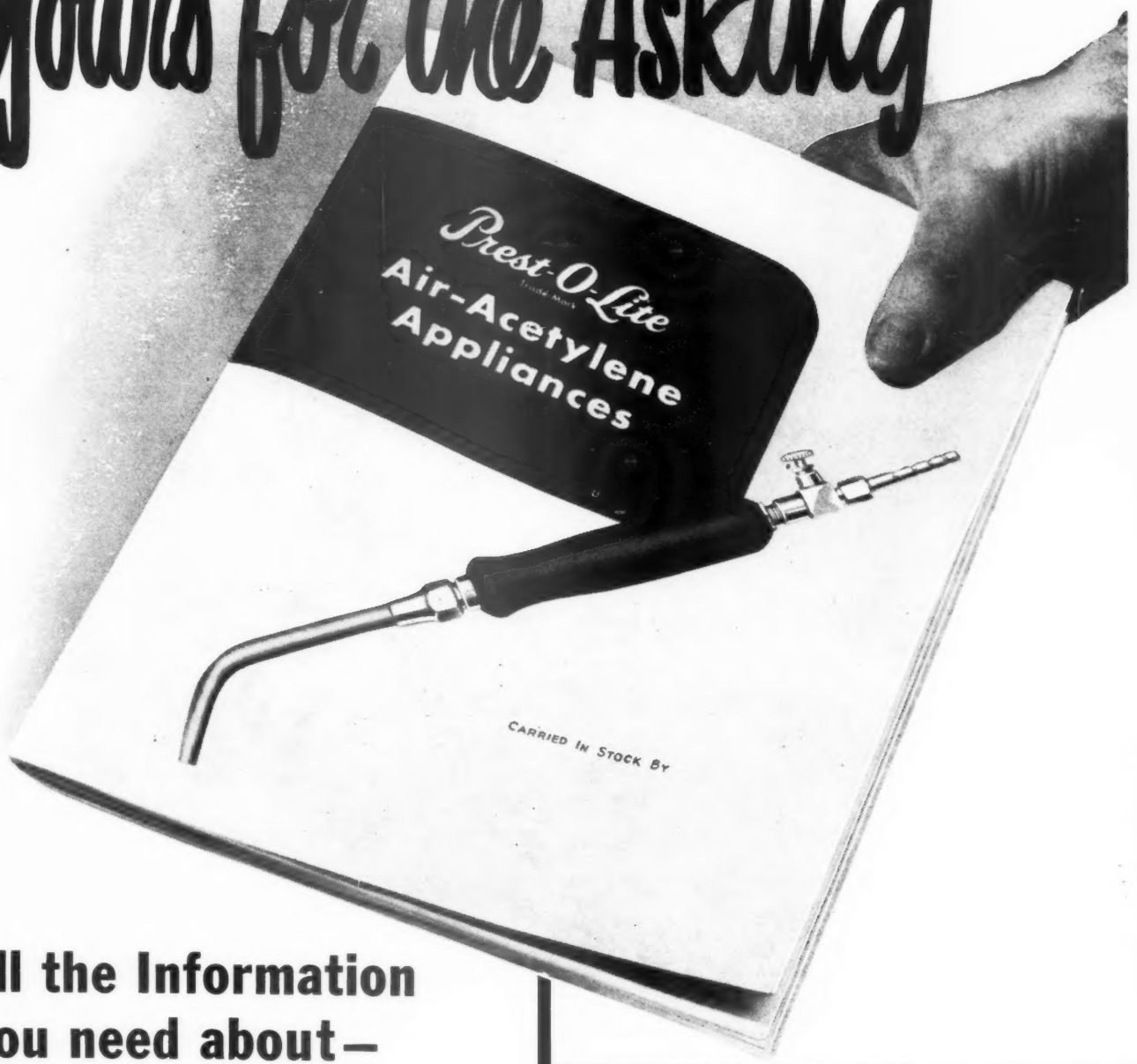

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Surface geology beneath the Sea

By J. L. CHASE, Consulting Geologist

IT has long been known that geological traps suitable for oil accumulation lie offshore on sea or lake bottoms but only in recent years have investigations and drilling been carried farther seaward than immediately adjacent to the beaches. Exploration operations in the open sea can become quite expensive unless adequate planning and consideration of the many factors affecting the work are properly evaluated. A method that takes in all these factors, which has been used successfully off the California coast, and that is applicable to most areas, is discussed in this article. This method involves soundings and samplings when necessary, but its particular interest lies in the means employed in the taking of oriented cores.

EXCLUSIVE

It is assumed that the ocean beach offers the geologist no adequate geologic outcrops to permit the projections of anticlines, faults, contacts, etc., seaward.

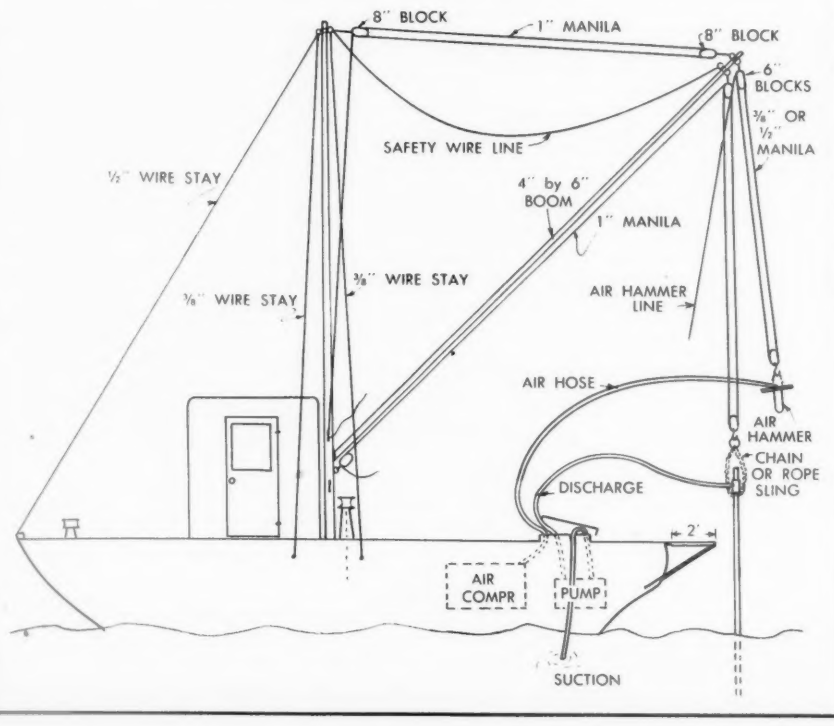
Sea action ordinarily cuts a bottom profile that is concave upward in all types of formations, viewed normally to the beach. If profiles are encountered that are convex upward, an explanation is to be sought in faulting, folding, intrusion, wave deposits, or deltas. Wave deposits and deltas usually exhibit a certain symmetry as regards their position with respect to the shoreline and to existing influences, and therefore may be separated after careful study of sea bottom topography that is based on structural events.

Owing to the sea acting as a huge horizontal saw, the bottom topography in general will be low; therefore, profiles need to be exaggerated in the vertical scale to bring out the salient points. The exaggeration should not be carried too far, however.

THE AUTHOR

Chase, whose home is in Long Beach, California, has been connected with the oil industry since 1918. Structural geological studies have been his main work. Investigation of sea floor out-crops of formations was begun off the State of Washington. Later similar work was done in the Long Beach area. In 1932 he did a limited amount of this type work bordering Cuba. From 1932 to 1937 he made a full-time investigation of undersea geology from Newport Beach to Point Conception and near some of the Channel Islands. Since 1937 several short-time detail studies have been made at sea.

The boat is rigged up as here shown for coring operations.



● **Effect of currents and surges.** A sea bottom study requires consideration of modifying agents such as currents. Ocean currents present a highly complicated subject and the literature on them is voluminous, but it is frequently somewhat conflicting because of cursory studies by various engineers or by failure to take into consideration all the factors involved. Some of the currents that do, or might, affect an area are wave, tidal, wind, hydraulic, and possibly eddy currents and seiches, also river and reaction currents at certain points along a coast. Currents that probably do not affect, or do so feebly in any event, are pressure, convection, salinity, and planetary currents.

Wave currents are caused by two types of waves at or near the shore, oscillatory and translation. The first causes a back-and-forth movement of bottom particles, but due to the slope of the bottom it usually causes a seaward creep, but if the waves strike the shore obliquely they will cause a longshore progressive movement. The second type, translation waves (breakers are of this type) move only in one direction, in periods. They also will set up a longshore current when striking a beach obliquely. Ground swells always move landward, whereas storm waves may move landward or seaward. If swells are oblique to the shore they will cause longshore drift, sometimes against the prevailing winds. Waters involved in beach drifting have a high velocity, whereas tidal or other currents may be too weak to carry anything but the finest sand.

Wave and wind currents are extremely effective close to the shore in shallow water, whereas a tidal current may be sweeping with irresistible force only a short distance away in water of moderate depth. Tidal currents affect the work of divers more than do large surface waves. The same wave may drive coarse material shoreward and fine material seaward; for example, a wave with a steep wave front has a short, quick forward motion, whereas the backward motion is slower and longer.

Tidal currents are large-scale oscillations. Far at sea their orbit of motion is circular but in shallow water the orbit becomes elliptical with the long axis pointing just above the shoreline; that is, nearly parallel to bottom. The transporting and eroding power of such currents may be enormous. Rocky ridges have been reported swept bare at a depth of 6500 ft by such currents. A strength at least as high as 12 knots has been recorded, and along the California coast 3 knots is not uncommon. They do not commonly act in a direction nor-

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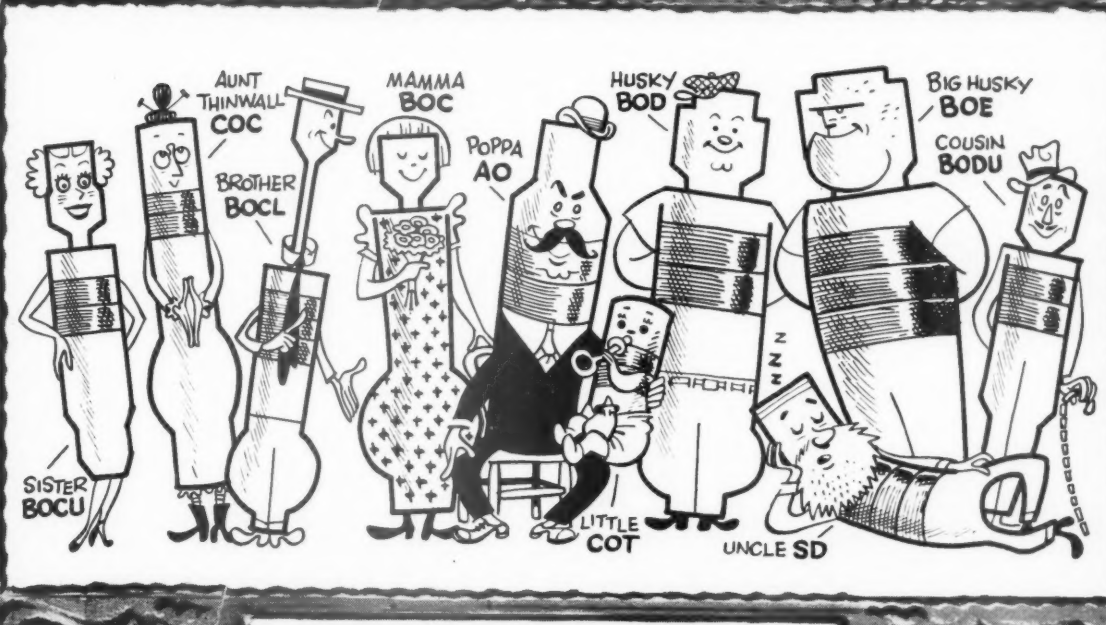

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mal to the shoreline because shoreline irregularities deflect them, creating longshore currents in all possible directions. They are then usually much stronger or swifter than movements normal to the beach.

Wind currents are caused by the wind dragging the surface particles along with it. The water surface acquires a velocity somewhat less than the wind and the current gradually diminishes in depth, but the entire body of water may be set in motion in the course of time. The velocity depends upon the strength of the wind, length of time blowing, as well as the shape and size of the water body. "Length of fetch" is very important. Near shore a velocity of 2 to 4 knots is common. Winds are extremely effective in producing hydraulic currents. A strong wind blowing for several days may cause a temporary current that has so strong a "set" that bottom debris is moved longshore. (Oblique impact.)

Hydraulic currents usually occur in conjunction with other currents; in fact, they greatly complicate the true tidal movements as they may have the same periodicity as the tidal current when caused by that particular tide. Tides raise the water higher on one part of the coast than on another and this causes the water to flow by gravity away from the high points. (Barometric highs and lows at sea likewise cause differences in water level, with currents resulting therefrom). The currents are probably feeble as a rule but in a very shallow bay they can move fairly coarse debris, especially with agitation. Onshore waves likewise raise the water level, causing a downward flowing current. Wind also raises the water level, but only slightly on steep coasts with deep water close in. Bottom currents move toward land when the wind blows offshore. This is noticed by bathers who are chilled by the colder water from beneath the sea. Undertow is a hydraulic current.

Seiche is a periodic oscillation varying from a few minutes to several hours and is not well understood. Seiche currents have usually been studied in lakes or land-locked areas, but they also occur in bays and straits and if their amplitude is considerable they cause movements that are somewhat similar to hydraulic currents.

Eddy currents are closely related to reaction currents and result from the dynamic force exerted by moving waters on the other type of currents. Eddy currents are surface whirls.[1]

● **Ground swells.** In sounding work or coring operations at sea a very troublesome factor is Ocean Surge (swells), which causes severe, sudden horizontal movements that on occasion may be as high as 25 ft. For many years a study of surge has been made and its cause is believed to be the dying end of storms occurring far at sea that have combined with other waves and are impinging on the shore. Wind and atmospheric pressures probably caused the original waves that later combined with other waves to form a surge. Superimposed on these swells, which at times reach heights of 4 to 6 ft above their troughs and which are 600 to 2000 ft from crest to crest, lie the usual sea waves seen along the coast. During local storms, which create waves 15 to 20 ft high or more, the swells (surges) may raise the height of water at the beach to such an extent that large damage is done to houses built nearby. At Newport-Balboa, California, such action has caused the sea to flow across the peninsula into the bay; at Long Beach, California, and along the Santa Monica coast, houses have been swept into the ocean. Although a combination of swell (surge) with a local storm is rare, nevertheless it does happen.

Unless work is being conducted this surge, when occurring, is rarely noted on clear stormless days, but it is on such days that it is apt to interfere with sounding or coring work. Surge occurs with more frequency than is generally believed and anyone doing ocean work will benefit by noting at a reference point the height of waves and their period of passing in seconds.

Wave length in feet on the open sea is normally about $5\frac{1}{8}$ times the period in seconds squared. Although the velocity and wave length decrease upon entering shallow water, the period of swells remains unchanged. Ratio of height to length of waves range from 1:3 in storms to as low as 1:50 in calm weather.

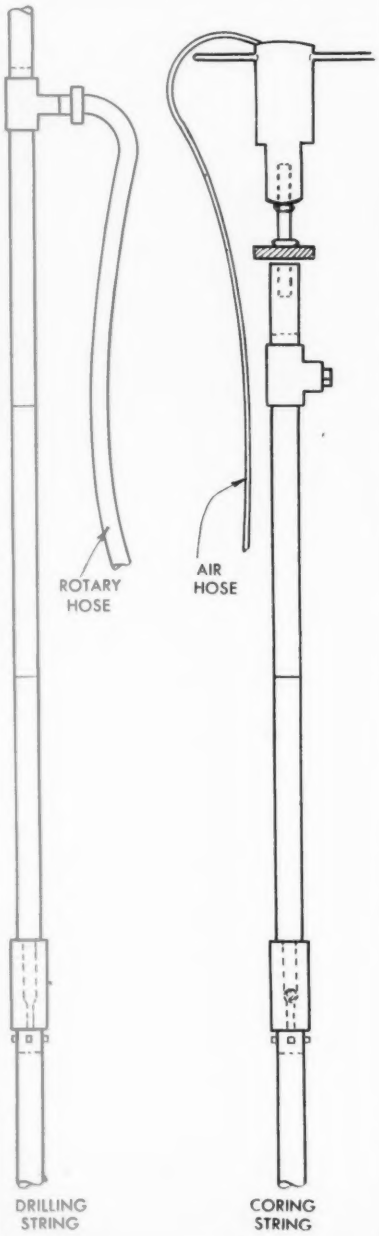
Observation often will reveal conditions existing on certain days that will hinder or prevent certain work at sea from being done, even though the day appears to be an ideal one otherwise.

● **Sounding and sampling operations.** In order to isolate areas of probable oil possibilities at sea from the much larger areas of faint or no oil possibilities, sounding and sampling may be of immense value, provided the area is or has been a rising one and has been subjected to ocean scour. Coastal areas of subsidence over a long period of time are not suitable for sounding or sampling work.

Sounding and sampling may be done from a light motor boat, in fact from any kind of a boat that is seaworthy. Equipment is light and readily available, but sounding work for geological purposes must be more exacting in technique than is commonly employed for other purposes. For example, sounding depths should be accurate to within $\frac{1}{2}$ ft (repeatable), sounding lines should be straight and run normal to the shore and not parallel with it, a large scale tidal graph should be employed and all soundings timed and corrected accordingly,

Ready to run grab sampler.

The drilling and coring strings are manipulated from a platform at the stern of the boat.



[1]For more detailed information regarding currents refer to "Shore Processes and Shoreline Development," by D. W. Johnson. John Wiley and Sons, Inc., New York.

"HERE'S HOW WE REACHED PAY SAND EIGHT DAYS AHEAD OF SCHEDULE!"

THE going was pretty rugged. We were drilling in pyrite, granite, and quartz. Progress was practically nil. After a chat with one of the Hughes boys we decided on a new plan of attack. We put about 36,000 pounds of drill collar on a nine-inch Hughes W7R bit and cut our rotary to about 50 r.p.m.'s. From then on it was comparative "duck soup." I guess that slogan of Hughes, "An Engineered Solution for Every Drilling Problem," just about "hits it on the nose."

HUGHES TOOL COMPANY HOUSTON, TEXAS

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the rise and fall of surge (swell) should be known and allowed for, and the position on the wave should be consistent (it generally suffices to use the two halfway positions from crest to trough).

It has been found satisfactory to locate the survey line by two simultaneous sextant angles to shore points (previously set or on an air map) at the beginning and end of each line and at two-minute intervals during the run. As all operations are timed and the boat is kept at a uniform rate of speed, close accuracy results. Sampling work with a grab-type sampler usually follows later and each sample taken is individually located by sextant angles.

This type of work permits the covering of a large area in a reasonable length of time, the personnel can be quickly trained, and the cost is low by comparison with any other method. It, therefore, is very much worthwhile when geologic conditions warrant its use.

In the summer of 1928 considerable sounding and sampling was done at sea along the coast of Washington, principally at and north of Hoh River. Many islands lying offshore having good outcrops of formation helped to secure control of the geologic data obtained from the sea floor, as shown in an accompanying photograph. The time spent on this project, however, was inadequate to solve all geological structural problems that occurred.

Attention is called to the fact that ocean currents acting on uplifted formations over immense areas off the coast are swept bare of debris and that splendid outcrops occur beneath the sea (especially along the Washington coast) whereas on shore the formations are generally covered by timber and brush except at seacoast bluffs.

As ocean bottom geological work progressed it was realized how many data were lost off the coast of Washington because of improper technique.

In the winter of 1928 and during parts of 1929, 1930, and 1931 sounding and sampling work was carried forward along the Southern California sea coast, principally in the Long Beach area. It was while doing this work that it became known that some type of folding or faulting passed over the area now known as the Wilmington oil field. Due to lack of experience in this type of work at that time much of the data found could not be interpreted properly; but a map made in 1928 showed an anticline across the Edison Company power plant on the west side of Long Beach Harbor entrance.

From 1932 to 1937 marine geological work was extended, methods were improved and coring was added to the technique. A great deal could be written about the early attempts at coring, especially the many escapes some of us had from serious injury or death. These later marine geological surveys extended from Newport Beach to Point Conception, California, and included work off some of the Channel Islands.

In 1937 the present methods of coring were inaugurated. Since then these methods have been improved more by simplification than by any other means. The original methods were based on suction and hydraulic ram principles and were not found to be dependable under all conditions. Moreover, the tools employed were easily damaged.

● **Oriented coring operations.** Following sounding and sampling work (or without such preliminary steps where conditions indicate them to be unnecessary) oriented cores may be taken on bottom or below any cover of washed-in materials that exist on the bottom. Strike and dip, as well as micro-paleontological and mineral content, will be revealed by coring. Any possible oil traps disclosed by this work should, of course, be further examined geophysically for axial inclinations, etc., as such would affect the proper location of a test hole to depth.

The equipment and operations outlined here were successfully used in open, unprotected ocean work in the Pacific Ocean. Some of the factors that influence such work will be cited. Ocean conditions on the coast of California are decidedly different from those encountered in the Gulf of Mexico. The water deepens seaward much more rapidly and in many places the bottom is rough and uneven due to geologic formations cropping out. (Rising seacoast).

Probably the most disturbing factor in coring is the heavy surge that, frequently occurring even in fair weather, will move a boat or barge as much as 25 ft horizontally, movements of 6 to 12 ft being rather common.

The vertical up and down movement of the sea is not so troublesome unless the tools become stuck. Then when attempting to use jars the stroke is too little or too much, and severe breakage can result unless jarring action is carefully timed with the sea motion.

Off-vertical movement of the lifting boom (derrick) and weight of tools prevent the use of light boats so a heavy type fish boat is required.

It is next to impossible to eliminate all drilling hazards even on land—and at sea the risk is magnified by unsteady footing. For this reason, the writer's experience has been that seagoing men make the best operators because they are accustomed to similar risks in their usual occupation.

Coring work was performed in a manner similar to the Canadian Pole System, except that heavy geological drill pipe (1¼ in.) was used instead of wooden poles and that circulation was added.

Handling drill pipe on a small boat is very inconvenient. To overcome this a steel three-leg extension derrick 30 ft tall was made with wide-spread legs, the lower part being made from 2-in. tubing and the upper extension part of 1½-in. pipe, the whole lightly braced. About 1 ft above the base of each leg a ¾-in. by 2-ft by 2-ft plate was welded and braced to prevent undue sinking in any soft bottom sands and to add weight. This derrick was lowered into the water from the after end of a boat and then the boat pulled clear. Two anchors with long lines (at least a 1 to 3 slope) were put out on the seaward side of the derrick

Type of boat suitable for coring operations. It is preferable, however, that the foredeck not be of the raised type as shown.

Anticline and syncline appearing in bluff on north side of Hoh Head, Washington. Ocean work determines best place to drill.

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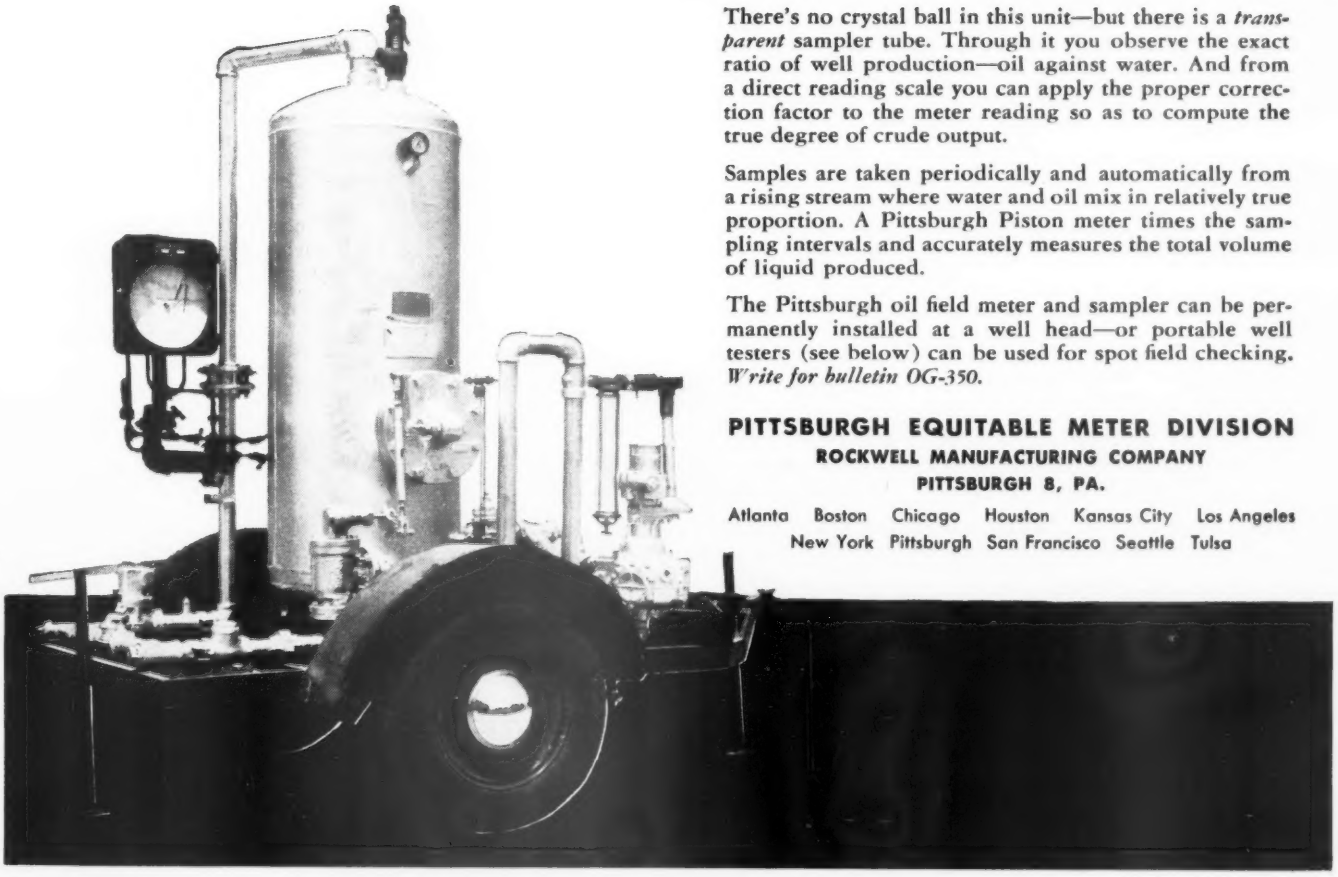

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and by means of lines and blocks the top or bottom of the drill string could be handled at the derrick. Drill pipe was in 10-ft lengths and an operator on top of the derrick added pipe as required. This operation proved to be good but slow, provided there was no surge; but the derrick was tipped over three times by surge despite the anchor lines. A third anchor line placed on the shoreward side might have aided stabilization but the derrick operation was not believed satisfactory and so a different procedure was sought.

For many years washing through bottom sediments (debris) has been used in harbors and at sea but because of doubt regarding ability to orient cores from such holes it was not tried at first. This method of drilling from a boat without a derrick set in water was finally resorted to. Although this operation is more hazardous than derrick operation it has proved to be entirely practical with the equipment in use out to a depth of 60 ft of water. Beyond that depth the 1¼-in. pipe used for the purpose becomes too limber to permit orientation. It is believed that 2-in. pipe will be practical out to 80 ft or more of water, but this has not been tried. (Equipment has been designed to core in 1000 to 2000 ft of water but it has not yet been tested at sea).

The drill string is oriented from the boat by sight vanes to points on shore whose bearings are known; so by marking the pipe before and after taking a core the mark can be carried downward to the core, thereby proving orientation. During actual coring any rotation that occurred has been too small to be detected. Orientation so provided appears to be correct within 5 deg of error.

Above a heavy-duty tee (3000 psi) a short blanked-off nipple is inserted, this nipple being hard-faced on its upper end. Into the upper end a special air hammer drill rod adapter is inserted. It has been found impossible to prevent very rapid breakage if an air hammer drill rod is welded to the top of the short nipple.

By means of a light block and tackle a heavy pavement-breaker air hammer is placed on the top of the drill rod for coring purposes only. Air hammers run too fast for coring but by operating them in a series of short bursts good results can be obtained at the expense of length of core. A more efficient blow would be one striking about 200 lb at one-half to one second intervals, or simulating a small pile driver. Standard pipe threads on drill pipe do not suffice for air hammer work.

Prior to coring operations a circulating hose leading from a 3-in. centrifugal pump is connected to the drill pipe tee. Salt water is circulated through the drill pipe, with core barrel attached to bottom, and the entire string spudded at the same time. No cover exceeding 30 ft has been encountered during the ocean work, but on land work previously done the circulating fluid has had to be changed to mud (aquagel and water) when reaching a depth of between 60 and 70 ft. The cuttings could not be pumped out of the hole in soft formations at 70 ft and this depth caused severe bridging and stuck pipe as well as large caving at the top of the hole. After changing to mud no further trouble was encountered to depths of 178 ft. Without a much more elaborate installation than was used on this work any mud pumped down a hole would be lost into the sea.

After washing and spudding down to what appears to be beneath all cover, circulation is stopped and, upon breaking the hose connection into the side of the tee, a 1-in. steel ball is dropped in the pipe for core barrel operation and a plug then placed in the tee, at which time the air hammer is swung into position. Usually two men have pulled down on the air hammer while it has been in operation because most of the cores have been taken in tough hard shale. A third man helps keep the drill string vertical. No driving has ever been done while the pipe was off vertical. A fourth man handles the main hoisting line.

Most of the cores to date have been taken in a sticky type of clay shale and the tools would stick and have to be jarred loose. Many different type jars might be used for this purpose, but a simple effective type consists of a heavy weight (75 to 100 lb) running free just below the tee and swung by chains to a ring, from which a rope leads through a block on the boom and thence to a winch. By holding a grip at the winch with 2 or 3 ft of movement for the weight, two men can spring the line and cause the weight to strike an extremely hard blow. Even on bad sticks five or six blows would free tools but usually only one or two blows have been necessary.

The core barrel is simple. It consists of thin wall tubing hard-faced on the bottom and ground to a sharp cutting edge, flush on the inside, with an outside bevel of approximately 30 deg. A flatter angle prevents tool from penetrating as easily and does not appear to render any better service life. Whatever may break or damage the 30-deg edge will do the same to a 45 or 60-deg edge. When hard-facing, the outside diameter is slightly increased and in later grinding nearly all the excess diameter is taken off; in any event no more than 1/16-in. increase should be on the edge, preferably less.

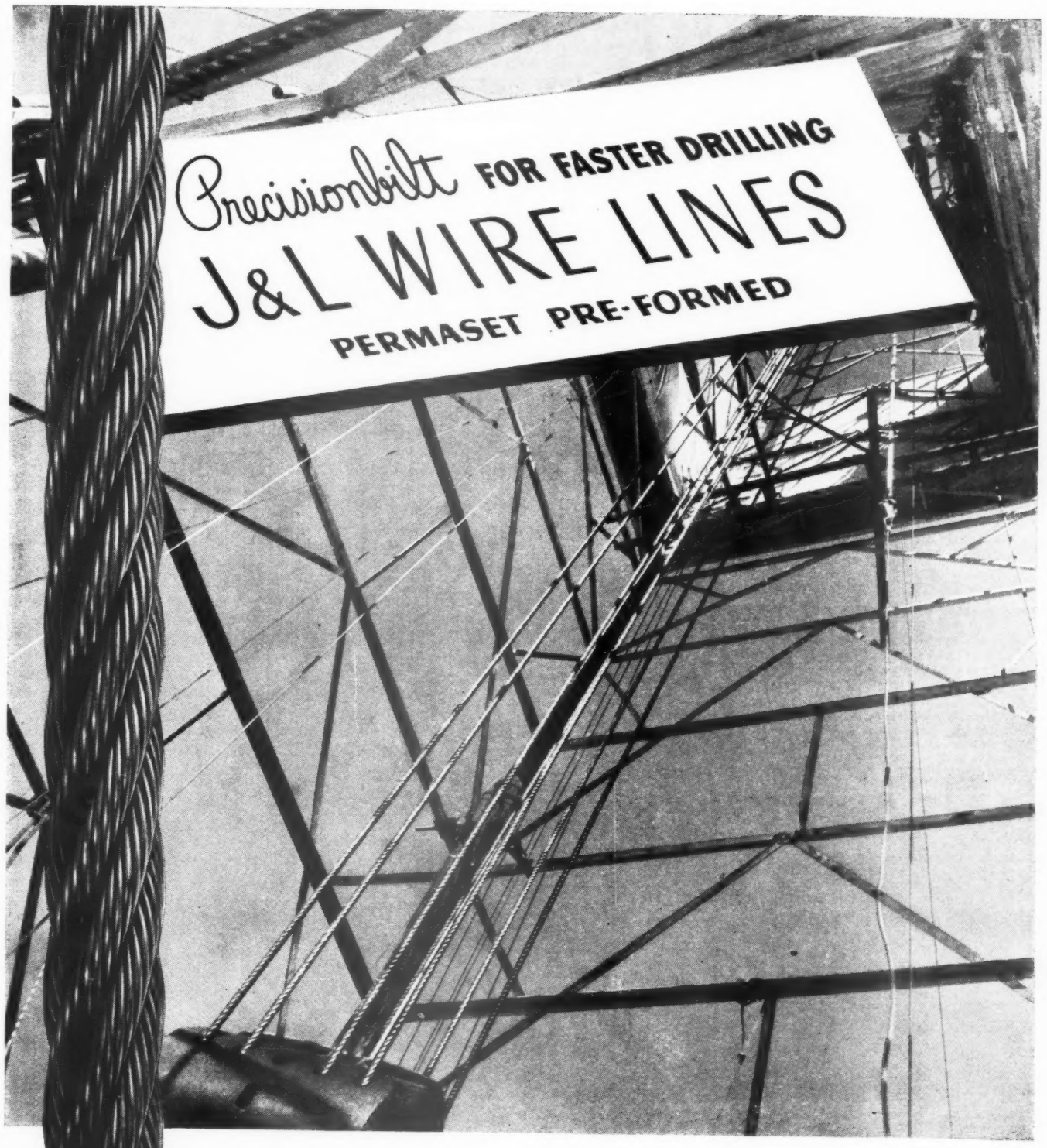
An adapter, with box end up to fit whatever tool joint threads are used on drill pipe, is placed in the string to accommodate the core barrel. Through this adapter is drilled a ¾-in. hole and this hole is counterbored part way to seat the 1-in. steel ball, which is dropped just before coring.

As the tubing employed for the core barrel is too thin for threading, other means of attachment are provided as follows: The lower end of the adapter is made the same size as the outside diameter of the tubing and a cut is then made to 1½ in. from the end, which just allows the tubing to slide on. This leaves the upper end of the tubing snug against the shoulder and it is held there by four ⅜-in. by ½-in. SAE cap screws. In coring thousands of feet of hole no core barrel has ever been pulled loose and lost.

The outside diameter of the tubing used is 2 in. and the inside 1⅞ in. It is of high carbon steel and meets the requirements of the work. It is cheaper

Close-up of the syncline in bluff at Hoh Head, Washington. This shows poor outcrop of anticlinal axis on the land.

Islands near La Push, Washington. Because of faulting, it is necessary to explore the structure beneath the sea.



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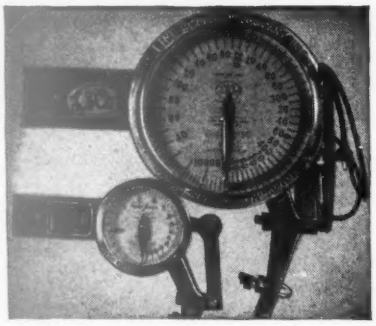

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than nickel or other alloy steels but naturally rusts more rapidly.

On land, cores up to 10 ft long have been taken (using different power) but part of the core underwent compaction and it has been found better to limit the length to 5 ft.

At sea it has been found more satisfactory to limit core lengths to 3 ft or under because of loss of time in freeing stuck cores when operating from a boat. Much longer cores could be taken of soft sandy beds.

The boat preferably should have a hatch sufficiently large to permit the air compressor (which should have a capacity of 105 cu ft per min) and the 3-in. centrifugal pump to be stowed below deck. (An 85 cu ft per min compressor can be used but is not so efficient.) While running the engines, the hatch cover can be kept partly open with short exhaust pipes taking out the fumes from below. This does not require boat alterations. The deck on both sides of the cabin should be nearly flat and as long as the boat. The boat rail should be low—not more than 1 ft in front.

The boat mast must be large enough and strongly enough guyed (⅜-in. and ½-in. guy lines) to permit installation of a 4-in. by 6-in. boom that extends over the stern far enough when it is raised to the 45-deg position to allow the drill pipe to hang with a 2-ft clearance from the drilling platform. A double eye heavy boom fitting should be made in a welding shop for the operating blocks and lines that handle the tools and jars. A second fitting with one eye pointing downward and one upward is also required for the boom in addition to the usual type fitting for the mast end of the boom, which later might also have to be made, depending upon original type on the boat.

The boat should be 40 ft or longer and preferably should be diesel powered. It should have enough beam and be heavy enough to provide good stability.

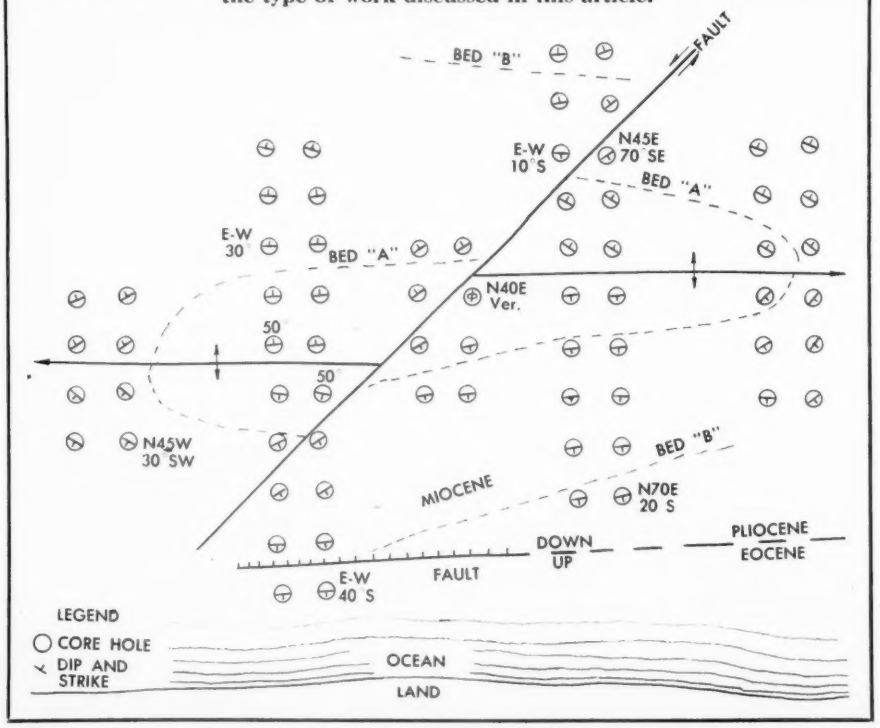
A 2-ft wide platform across the full width of the stern needs to be built for working room out over the water. It may appear advisable to make this platform partly round or horseshoe shaped, but such a shape prevents men from getting clear of the drilling tools if the boat is suddenly struck by swells. It is better to get wet than mashed. Due to the normal wobble of a boat it does not always move in the same direction when a swell strikes it.

For extensive work in any part of the world a schooner with a diesel auxiliary power could be readily equipped for this type of work. With a boat of this size a core laboratory and paleontological and other equipment deemed necessary could be installed to make a complete servicing unit.

Three anchors with chain and about 300 ft of anchor line each are needed. Also a small skiff for carrying out anchors and for other purposes. By using three anchors with long lines and proper manipulation, up to four cores at approximately 100 ft spacing may be taken at one set-up. Each core can usually be taken in from 10 to 30 min. Preparation for making the set-up is time consuming and it is advisable to drill as many holes from each set-up as possible. Closer hole spacing increases the number of cores that can be taken in a day.

Two set-ups constitute an average day's work, giving eight oriented cores; that is, if depth of water does not exceed 60 ft and the bottom covering is light, perhaps not exceeding 15 ft. The deeper the water and thicker the bottom covering the longer time is required to

This hypothetical geological map indicates the data that may be obtained from the type of work discussed in this article.



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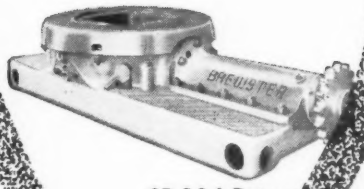

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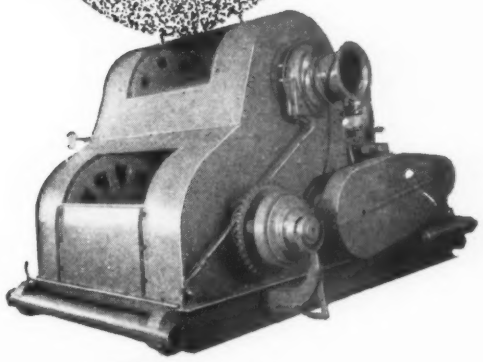

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take a core. If the water is shallow (about 20 ft) and the sea is smooth, 12 to 16 cores may be taken in a day's work, if hole spacing is appreciably reduced. Cores are extracted from the core barrel by means of the usual hydraulic pump.

For best operation a 5-man crew should be used, although only three are working all the time; it is safer and speedier to have two other men participate in the work during lowering and hoisting operations. One of the men should be a geologist so that core hole locations can be changed to suit geological conditions encountered.

Using these methods 178 core holes were attempted in the open sea off the California coast in water ranging in depth from 20 to 60 ft and extending from 200 ft or less offshore to nearly a mile seaward. Of this number 158 cores were successful. No cores were ever lost but on 20 occasions the core barrel was damaged by rocks to such an extent that cores would not enter. Because it was important to get cores in the rocks repeat runs were made regardless of the damage, until two cores were recovered at this place. On this project, two sextant angles were taken at each core hole location from objects ashore that appeared on air maps.

Orientation is usually correct to within 5 deg but could be made even more accurate; and the strike and dip map so obtained results in a very good geological map of any area. A hypothetical geological map indicating what may be found from this type of work is given in an accompanying illustration.

As much drill pipe as can be handled is made up on deck from 20-ft joints. The length of drill string may extend 15 to 20 ft over the ends of boat, hence the advantage of a boat longer than 40 ft for coring at depths greater than 60 ft. The hoisting and air hammer tackle are employed to get this pipe in and out of the water. Additional short joints (5 to 10 ft lengths) are added from the working platform by letting pipe rest on bottom and adding a joint by aid of the air hammer tackle. Just before coring it is sometimes necessary to adjust the top of the drill pipe to a convenient height for operating the air hammer and for this purpose several short pieces beginning with 2-ft lengths are kept on hand. If coring is easy a loop of rope may be placed over the air hammer to operate the trigger from any height; this saves time when cores will cut without much pull down. Otherwise a rope pulls the tools out of vertical.

The cost of coring work at sea is difficult to predict because of weather and sea conditions. It also depends upon the time of year (as well as what year) work is done if the boats employed in the work are to be rented. During the fishing season it is extremely difficult, or even impossible, to obtain a boat, but if one can be obtained its rental cost will generally be found to be much higher than when the fish are not running. If a boat can be obtained for work at any time of year it is preferable to work through the summer, late fall, and early winter; so far as California is concerned, February and March are usually the roughest months. Although severe storms occur at times on the Pacific Coast during the winter, the sea is in general smooth, but it is cold on the water and light breezes feel much stronger than they would if occurring in summer.

Considering present costs it is believed coring work at sea could be carried on for a cost of not to exceed $5,000 per month, and less than that figure per month if the work continues over several months' time. The cost per foot is not really very high where cover exists. All hole drilled before reaching adequate geological formations is wasted from a geological standpoint, but the cost of the entire hole falls upon the core, which makes each core appear expensive.

● **Conclusions.** The chief advantages of this type work is the accurate geological data obtained at relatively low cost.

More geological information per day can frequently be obtained from the sea bottom than could be obtained over certain large land areas, and danger of securing dips in formations whose attitude has been altered by land creep due to topography is practically non-existent.

Various places along a coast may be quickly checked by one or several cores before deciding to set up a grid system of regularly spaced core holes for detailing a particular area. * * *

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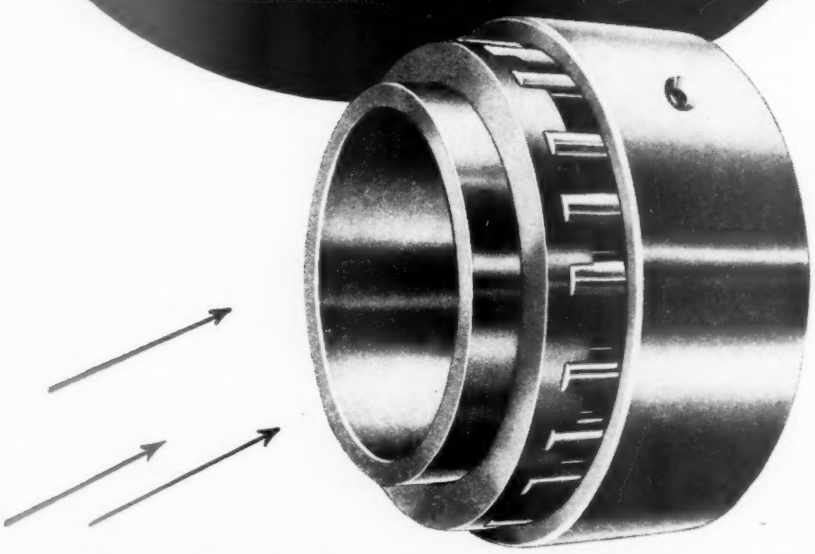

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By FRED L. PLUMMER, *Director of Engineering*, Hammond Iron Works

FREQUENTLY it is necessary to construct above ground storage facilities for fuel oils and other petroleum products in high-cost, built-up portions of metropolitan areas. In order to insure the safety of such installations and comply with municipal codes and standards, such as those of the National Board of Fire Underwriters, it is required that all tanks used to store flammable liquids be enclosed by dikes having a storage capacity as great as, if not greater than, that of the tank or tanks surrounded by the given dike. When crude oil is stored in such tanks the NBFU standards also require that dikes have suitable coping or deflector projecting inward, and be so designed and constructed as to minimize the effect of a "boil over" wave. Such a "boil over" wave may result if a mass of hot oil comes into contact with water that might have collected in the bottom of the tank or area enclosed by a dike, changing some of this water into steam and creating a volume of froth 1700 times greater than that of the water so transformed. It has been reported by the American Petroleum Institute that when certain oils burn, heat is carried down into the oil for some distance to a "heat-wave front" that forms a sharply-defined division between hot and cold oil. The possibility of a serious loss of product due to this effect is much less for a high dike than for a low dike, for the "boil over" wave will not be created until the oil level is within a few feet of the bottom and therefore several feet below the top of a high dike.

When adequate low-cost ground areas are available it will usually be found economical to space storage tanks far apart and surround them with low earth embankments having a height of from 3 to 5 ft, with a flat section at the top about 3 ft wide and side slopes consistent with the natural slope of the material used for the construction of the dike. Dikes of this type can be constructed economically with modern earth moving equipment.

When the cost of ground areas is high or when it is necessary to place tanks on ground having a steep slope, the use of steel or reinforced concrete walls result in a safe and economical installation. Such walls should be far enough from the shell of the tank that the scouring action of the winds will prevent the accumulation of combustible vapors within the dike. As concrete is not normally assumed to resist tension forces, the required area of reinforcing steel in a circular concrete ring wall subjected to hydrostatic loading is essentially the same as that required for a steel plate ring wall. The concrete serves to hold the reinforcing bars in place and to protect them from corrosion and heat. Under current conditions the excessive cost of material for forms added to the high field labor costs for constructing the forms and placing the reinforcing steel results in overall costs for a reinforced concrete wall that are considerably higher than those for an equivalent steel wall with adequate foundation. The use of dikes of rectangular shape or of other shapes requiring straight wall segment will usually result in higher costs whenever steel or reinforced concrete walls are used, for such walls and their foundations must be designed to act as cantilever retaining walls subjected to bending forces rather than ring elements which resist the liquid pressures by uniform tension stresses in a much more efficient manner.

Fig. 1 shows a type of construction used by one major oil company for storage facilities constructed in areas where it is essential that none of the stored product be allowed to escape, even by seepage through the ground. The steel bottom of the storage tank is extended outward and a second steel shell is erected, forming a steel moat or open top tank having a capacity equal to or greater than that of the closed tank that is used to store gasoline or other pe-

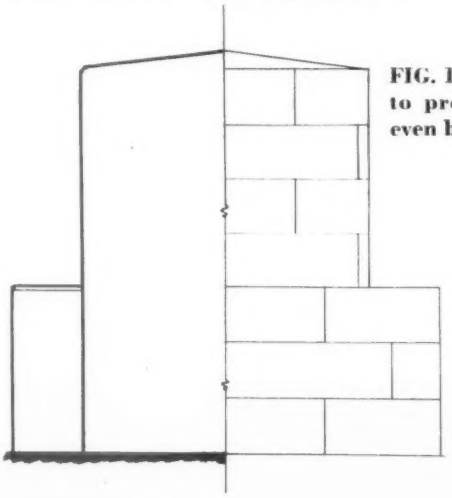

FIG. 1. Steel dike with steel floor to prevent escape of product even by seepage through ground.

FIG. 2. Steel dike under construction. Note the concrete foundation with part of the first ring of the steel in position.

FIG. 3. Spiral stairs leading to top of one of the 24-ft high steel walls and the walkway to the tank.

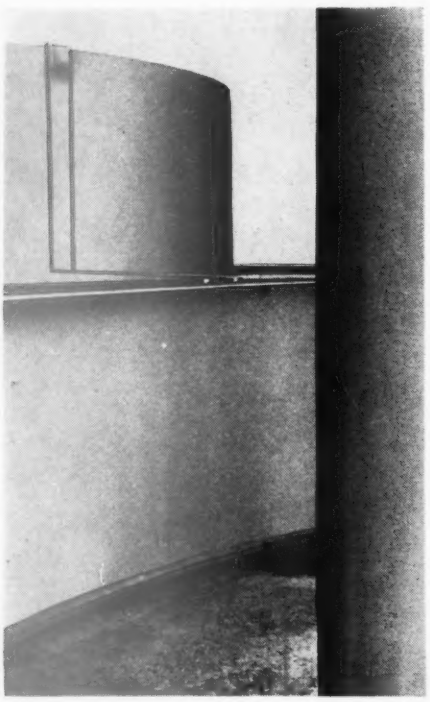

FIG. 4. A 96,000-bbl tank with its steel dike for fire protection.

troleum product. The additional cost of a steel bottom for the moat is usually not justified. Most steel dikes consist of cylindrical steel shells attached to ring foundations of concrete of sufficient depth to prevent the escape of liquid underneath the steel shell.

The Hammond Iron Works recently completed a typical installation of this type for the Coastal Oil Company at its Port Newark terminal. Local conditions at this site precluded the use of low earthen dikes and comparative cost estimates demonstrated the economy of using steel walls rather than walls of reinforced concrete. The installation included three new storage tanks of 96,000-bbl capacity each. These tanks have a diameter of 120 ft and are 48 ft high. Each tank was surrounded by a steel dike wall 24 ft high having a diameter of 172 ft. Fig. 2 shows an early construction view. The concrete foundation ring for one of the steel dike walls is shown in the foreground, with part of the first ring of steel plates in position. These plates, as well as those in the storage tank, are 8 ft wide and are butt welded. The plates are supported on small bearing plates spaced on 4 ft centers in the center groove at the top of the concrete ring. After the steel dike wall was erected and welded, the reinforcing bars shown extended above the concrete ring in Fig. 2 were bent over and welded to the steel wall. Concrete was then added to embed these bars. The height of the foundation above the top of the bars was raised with a mastic fill placed adjacent to both sides of the steel wall at its junction with the concrete. In the background of Fig. 2 may be seen the first ring of the steel dike wall for a second tank of which the first four rings have been assembled ready for welding. Two rings of scaffold planks and brackets for a third ring on this tank may be noted in this picture.

The top of the steel dike wall is stiffened with an inside wind girder that also serves as a deflector, which materially reduces the possibility of a "boil over" wave. This girder is wide enough to serve as an emergency walkway around the top of the steel dike wall. Fig. 3 shows the spiral stairs leading to the top of one of the 24-ft high steel walls and also the walkway leading from this wall to the shell of the tank and the tank stairs, which extends from ground level to the top of the storage tank. This illustration also shows the completed concrete foundation ring on which the steel wall rests. Fig. 4 shows one of the 96,000-bbl storage tanks with its steel dike ready to be placed in service. The complete installation including the three storage tanks, each with its steel dike, 24 ft high and 172 ft in diam, is shown in Fig. 5.

For this installation, earthen dikes of the conventional type would have required a ground area of perhaps eight or more acres, equal to about four times

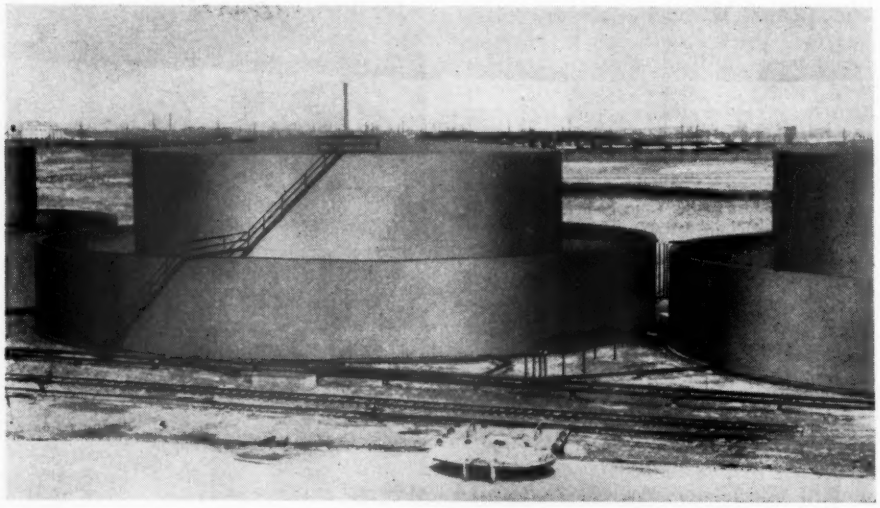

FIG. 5. Overall view of three 96,000-bbl tanks with their steel dikes.

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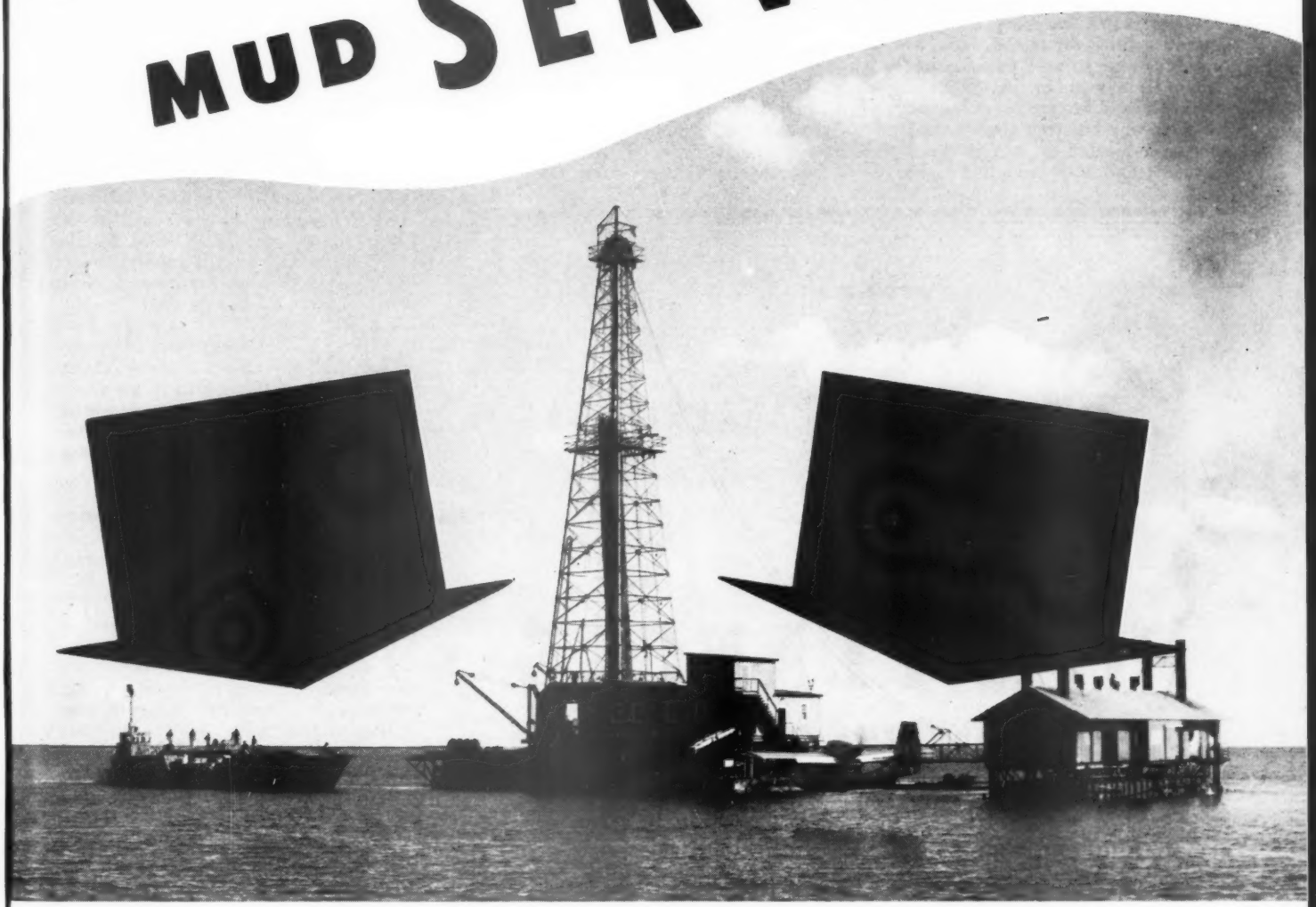

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the area occupied by the actual installation.

The design of steel dikes of the type described may be based on the rules given in API Standard 12-C for All-Welded Oil Storage Tanks. These rules do not at present cover open top tanks but will probably soon be revised to cover such construction. The formula given in the AWWA Standard Specifications for Elevated Steel Water Tanks, Standpipes and Reservoirs, covering the required action modulus for top girders of open top tanks may be used to determine the size of this member. As the circular walls of such dikes are not normally subjected to any bursting stresses and can only be subjected to such forces if the enclosed tank fails completely and releases the full amount of the stored product, it would seem logical to use somewhat higher working stresses when determining the required thickness of the shell plates. The API Code specifies for design purposes a base stress of 21,000 psi, a joint efficiency of 85 per cent for butt welded joints, and a liquid weight of 62.4 lb per cu ft. In a tank so designed and used to store oil with a specific gravity of 0.8, the maximum bursting stress in the shell plates would not exceed 14,280 psi. The inside of such tanks is not usually painted nor can it be easily inspected. Both sides of the steel shell forming a dike should be kept painted and can be easily inspected at any time. The use of a stress of 18,360 psi, corresponding to the value noted above, should result in a structure of adequate safety and reasonable economy. This actual working stress would call for the use for design purposes of a base stress of 27,000 psi, a point efficiency of 85 per cent for butt welded joints, and a liquid weight of 62.4 lb per cu ft.

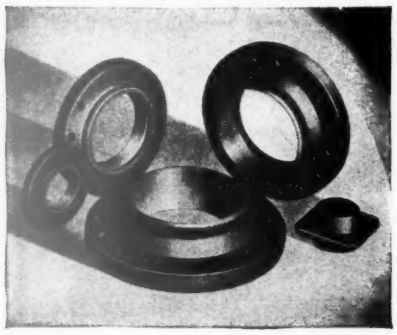
If as the result of a major failure a steel dike is filled or partially filled with burning oil or gasoline, relatively high temperatures may be created in the steel plate. Tests were made by the U. S. Naval Research Bureau at the Findlay, Ohio, steel plant of the Standard Oil Company of Ohio during July, 1945. These tests were made in an open top bank 93 ft in diam and 28 ft high. Two feet of product consisting of 30 per cent light ends (gasoline cut) of an Illinois crude oil floating on water so that the top of the oil was 14 ft below the top of the tank, was used. Temperatures of the steel shell, observed after a short pre-burn period, included the following: 338 F, 530 F, and 1050 F at points 3 in., 2 in., and 1 in., respectively, below the surface of the oil; 1210 F at the oil surface and 1440 F at a point 1 in. above the surface of the oil. Higher temperatures were observed at points nearer the top of the shell, the maximum observed temperature being 2400 F at a point about 8 ft above the surface of the oil.

The tensile strength of steel increases to a maximum value from 10 to 15 per cent higher than that at normal atmospheric temperatures as the temperature of the steel rises to about 500 F. At higher temperatures the tensile strength of the steel decreases. At 1600 F the tensile strength will normally not equal more than 20 per cent of the corresponding value at atmospheric temperatures. In the rolling mills such steels are normally heated to temperatures in excess of 2000 F for rolling operations.

As there are no significant tensile or compression stresses in the steel shell above the liquid level or at points a few inches below this level, it is evident that the temperatures resulting from the burning of product retained within a steel dike will not reduce its ability to safely resist the bursting stresses created by the pressure of the stored liquid.

Damage to storage tanks that have gone through fires without an explosion has usually been limited to collapse of the roof, sometimes pulling the top of the tank shell in and down, when the roof columns were weakened to the point where they could no longer safely support the roof load. The writer has observed fire tests in a shallow open tank that was used repeatedly without showing any evidence of damage or severe distortion.

For a deep open top tank, it seems probable that a fire of long duration might cause considerable buckling of the steel plates above the liquid level due to the expansion and contraction resulting from the sharp temperature gradients. Such distortion, however, would not affect the safety of the installation and might be such that filling the tank with water would restore the shell to its original cylindrical form. * * *



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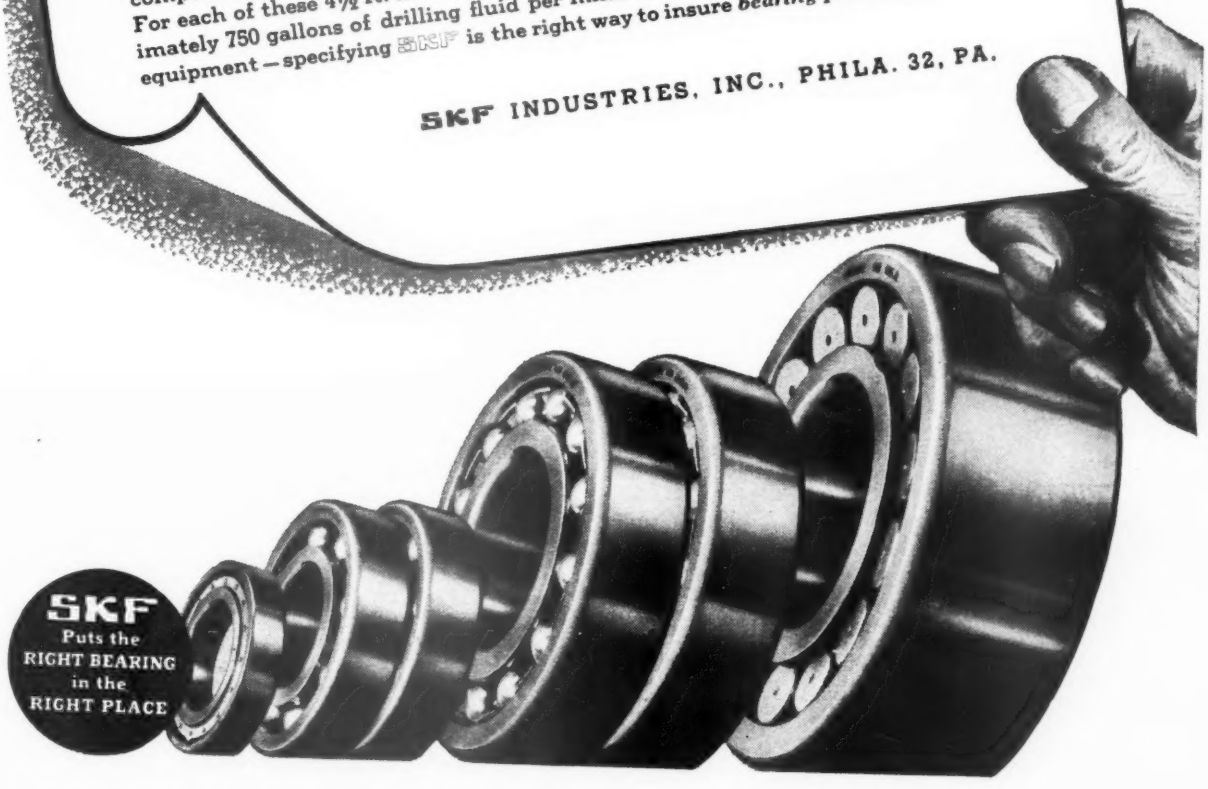

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Surveys for field gathering lines

By PEYTON BRYAN, *Division Engineer*, Humble Pipe Line Company

EXCLUSIVE

MUCH of the discussion published in a previous article on pipe line surveys* is equally valid whether the survey is being made for a "big-inch" cross country or for a field gravity line. In either case good progress depends upon the same factors: Physical briskness, "heads-up" team-work between all members of the party, and constant vigilance by the party chief against perversities of terrain and artificial improvements that attempt to place themselves athwart a pipe line alignment.

Field line surveys are of a more impromptu character than are the main line surveys, however, the relative unimportance of a few thousand feet of 4-in. serving a tank battery for three or four wells creates an impression of triviality in the survey problem that often turns out to be misleading. The man in charge of a main line survey will find grief enough between naught plus naught naught and the last hub, but his work is begun only after careful preparation, and he will always have a base-line of some sort with an accurate "fix" from which to take off. For field gathering lines, he will often find himself expected to begin a spur-of-the-moment survey from an unplotted position, the usual condition when he has gone out to stake the alignment for a discharge or gravity line from a new tank battery. He should, of course, have a district map upon which are platted all the completed and drilling wells, and the existing pipe line system, but only rarely will he have the location of an unconnected battery.

In open country, or if the battery has been set close to one of the wells, this lack is immaterial, for in the former case he can erect a tall foresight of lathes at the proposed tie-in and in the latter it will be simple to get a "fix" with reference to the well, determine the azimuth of the required line on his map, and take off "on the needle" until a land-tie enables him to correct his course. At times, he will find the battery remote from any recognizable tie, in woods or heavy brush, and the problem of spotting himself on the map will tax his ingenuity. I once dragged the chain for an engineer who, when confronted with this predicament, would run a stadia traverse from the unknown position around to the terminus of the proposed line, compute the latitudes and departures of his traverse, and from them calculate the required course. That, of course, will always succeed. Sometimes it might conceivably be necessary, but quite apart from the bare costs of the survey party, ranging perhaps from $100 to $200 per day, in pipe line work there seems always a press of emergency that encourages the party chief to find quicker methods.

Setting up the transit on top of one of the tanks to be connected, he can usually sight on an identifiable derrick or on a battery that has already been connected and platted on his map. To fix his position he requires the distance and azimuth of the platted object. The staves, or rings, of a standard oil field lease tank are 8 ft high, and the tank is usually two staves high. It behooves a surveyor doing work in the oil "patch" to learn and memorize such dimensions as the spacing of the horizontal girts on a derrick. On most rigs in this area they are 7 ft apart. Getting back to our man on top of the lease tank, he estimates a stadia reading on the girts of a derrick whose location is known, or reads the vertical angle intercepted by several girt-intervals to calculate the distance. A needle reading for azimuth would be worthless on top of the metal tank, so he turns off any convenient angle from the derrick to a hub set on the ground, which he then occupies and sighting back to his point on the tank reads the magnetic bearing of the latter. Combining this azimuth with the angle turned off of the derrick gives the azimuth of the derrick, and the position is "fixed."

There is nothing new in this, of course, nor in resecting a "fix" from azimuths on two or more derricks whose locations are known. The important thing is that a man doing pipe line surveys should familiarize himself with the standard dimensions of oil field equipment and fixtures in order to use them for estimating distances by stadia and angular calculation. What is the bolt spacing in the vertical seams of the lease tanks? How far apart are the treads in the tank stairways? How high are the gas separators, and what is the spacing of the rungs on the separator ladders?

For staking a discharge alignment all he needs is the azimuth of a direct line to the required terminus, but gravity lines make further demands on his ingenuity. The procedure will depend on the extent of the topographic data available to him before beginning his field work. If pipe line management could postpone moving into a new field until it had been fully developed, all tank batteries erected, and the productive limits established, then the pipe line engineer would lead a carefree life. His next best hope, and one that has been rarely realized, is to be provided with a reliable contour map of the district with the estimated productive area depicted. Given that he can lay out the whole gravity system in his office before sending a party into the field, where their work will consist in transferring the platted lines from map to ground. It sometimes happens.

Consider, for example, Fig. I, a cadastral and "topo" map of a portion of Mythical County, Texas, which we will assume to have been in our man's possession when the Anonymous Oil Company brought in the discovery well, Anonymous-Weavil No. 3, in the Elysian field, and requested a pipe line connection. The structure had been carefully worked out by the Anonymous geologists who, on the basis of three previous holes in the area, confidently drew in the estimated productive limits as shown. Now, lacking this information, had a party been sent into the field "cold" to run out the connection their natural course would have been southwesterly, as shown by the dotted line of Fig. I, down into the main drainage of Yerro Creek with the expectation of locating the field station in the B.U. & M.S. R.R. survey, directly on the 12-in. main line. Had our man acted on this seemingly obvious solution of the gravity system the eastward growth of the field would have been an increasing embarrassment; e.g., production from the second completion, Anonymous-Jurassic No. 1 in Section 21, could be connected only by laying a discharge line across the saddle and setting a "kicker," probably a 2-in. centrifugal, at the Jurassic Battery. Then, as production moved on southeasterly, the awkward pipe line pattern would have become more and more cumbersome (it is always difficult, operationally and psychologically, to act promptly in making a drastic revision of such error) until the sheer expanse of pipe and pumping equipment would have compelled a complete and costly rearrangement. "Which way is the field going?" is as important a question as "Which way will the oil gravity?"

We have assumed that our man has the answers to both questions. The bulk of the production will fall within the water-shed of Propio Creek, and the axis of the gravity system will have to be southeasterly. Hence, the line from the Anonymous-Weevil Battery is platted, on a "gravity" basis, across the saddle in the southeast corner of Section 18 and down to a proposed station site in about the center of Section 27. From that point it is laid normal to the 12-in. main line, to serve as a station discharge after the station is built.

*"Pipe Line Surveys," Peyton Bryan, The Petroleum Engineer, November, 1947.

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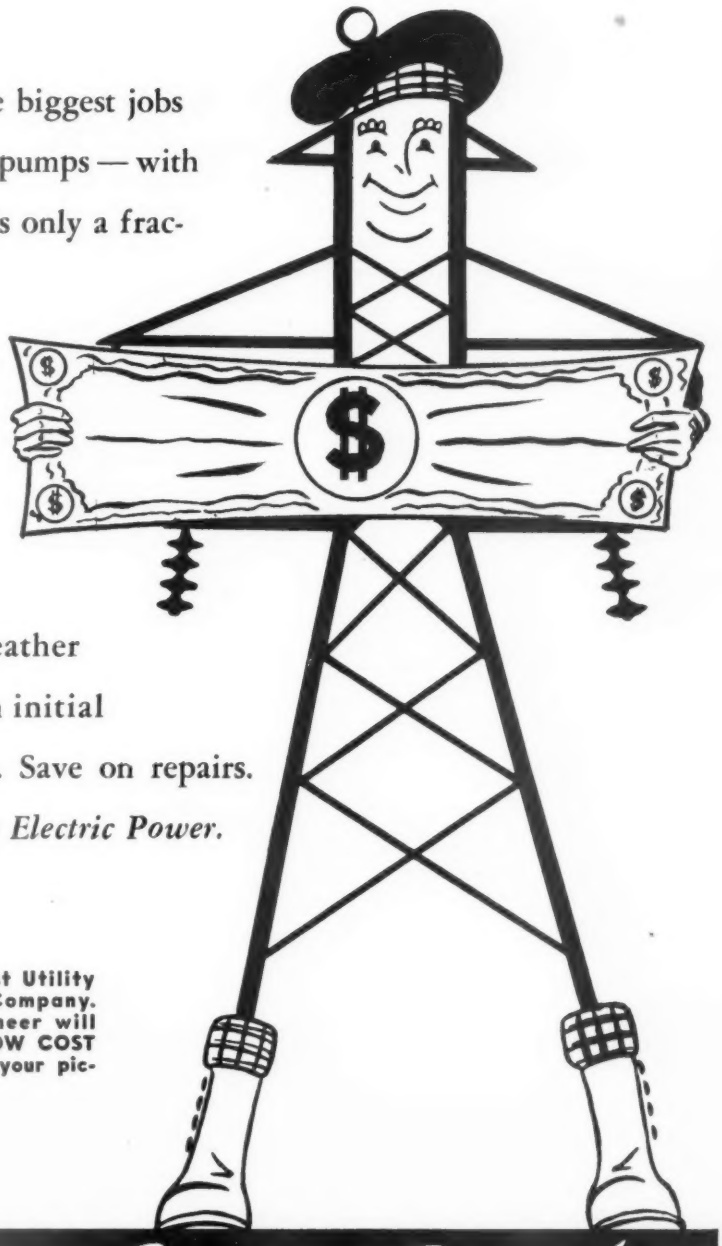

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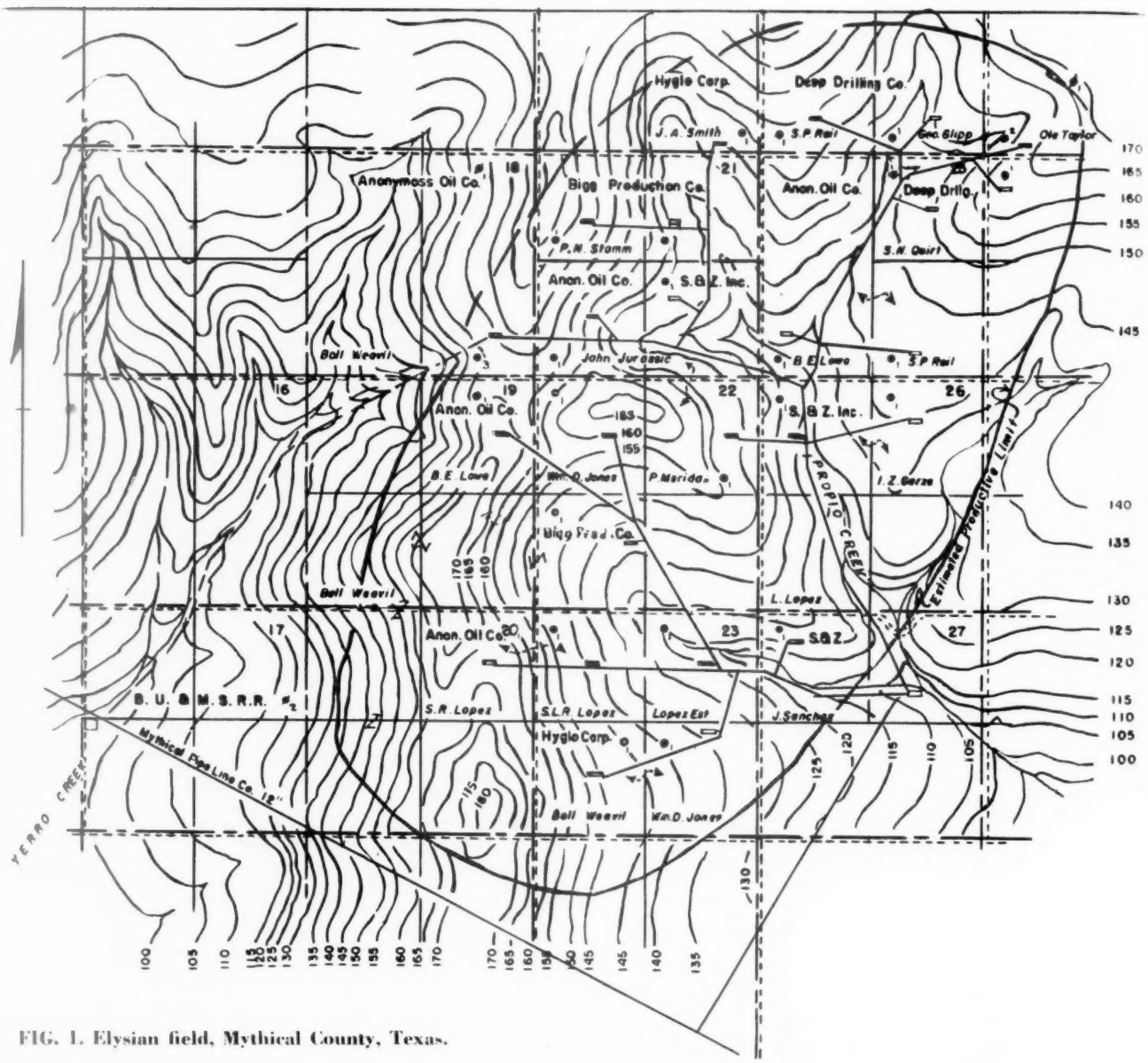

FIG. 1. Elysian field, Mythical County, Texas.

Let's digress for a moment into matters not so much concerned with pipe line surveying as with practical pipe line operation. They are included because the young engineer beginning work for a major pipe line company, or the consulting engineer doing occasional pipe line work, should acquaint himself as fully as possible with the related problems of construction and operation. The 12-in. main line of Fig. 1 will be carrying one, or several, grades of crude. If only one grade is being handled through the main line, and if the Mythical crude is sufficiently similar that no contamination would result from their admixture, then the Mythical can inject into the stream at any time. If the Mythical production cannot be mixed with the main stream it will have to be "batched," independently. In the latter case, all the stations up-stream on the 12-in. will have to shut down while the Mythical is "on the line." Although these considerations should have no bearing on the alignment chosen by our Mythical engineer for his discharge from the Weavil Battery, in practice they sometimes have an unfortunate effect. Assume, for example, that the 12-in. is located to the north of, and up-stream from, the Mythical field. If it is handling a crude with which the Mythical is miscible there need be no hurry in selecting a station site. A high-pressure low-capacity pump (90 to 125 BPH at 500 psi) is set at the Weavil Battery, and the discharge is laid on a "gravity" basis, as before, across the saddle into Section 21. From this point it is laid northward, normal to the main line, and as production moves southeasterly the pump is moved down-stream to each successive connection, by extending the gravity and discharge lines, until the field's limits have been defined and the permanent station site is located in about the same position as in Fig. 1.

On the other hand, if the Mythical crude is not miscible with the main stream it will quickly become necessary for the pipe line company to erect sufficient tankage to store the field's production during the periods in which the main line is not available. Hence, the need for a speedy decision on the station site. It will be a matter of gambling pipe against our faith in the eventual productive limits of the field, and if the decision has to be made as soon as two or three wells have been completed there will be a very human reluctance to put in a permanent station as far south as that of Fig. 1. It is the old problem of certain capital investment versus probable economy of operation, and there is no equation capable of solving it, for each new field sets up new variables. The tendency toward conservatism in initial outlay is so strong, however, that if there were such an equation a coefficient of 2 should be attached to the terms in favor of going a little farther down-stream. Experience seems to indicate that pessimism will mis-locate twice as many stations as will boldness.

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main line lies down-drainage from the estimated productive limits there is no reason for not putting the station as far down-stream as we wish, for the longer the gravity line the shorter the station discharge. This consideration has occasionally been taken into account, quite profitably, in surveying the alignments of main lines through areas of proved production along routes that fall close to the probable future station site.

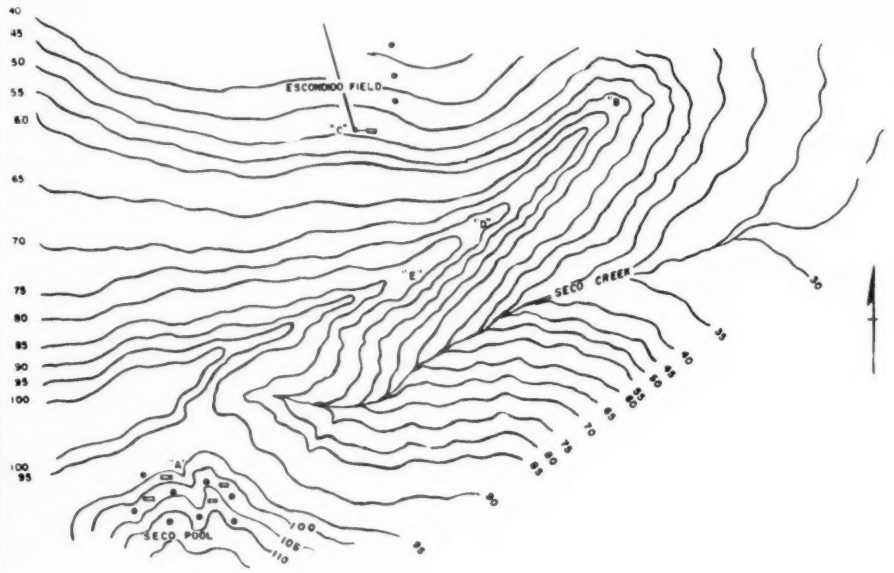
As previously noted, it will be exceptionally good luck for the pipe line engineer if he has the contour map of the field whose connection layout is to be designed. Lacking it, some degree of reconnaissance is required before staking the locations of any gravity lines. The extent of the reconnaissance will depend on the available time, the complexity or ambiguity of the drainage pattern, and on the degree to which the pipe line management is "sold" on the value of preliminary engineering work. In the open, rolling country of portions of West Texas and New Mexico, where the drainage is often poorly defined, it has been found a real economy to keep a plane-table party in the field, contouring areas that give promise of oil development. At the other extreme, in terrain such as that of most of the fields in northeast Texas, wooded and with drainage features as strongly pronounced as those of Fig. 1., it would be a waste of money to do any detailed contouring. A simple cadastral map of the Elysian field would show the principal water course of Yerro and Propio creeks; a few strings of levels along the roads would suffice to define the water-sheds, and suggest the outlines of the gravity systems.

Under these conditions, when the skeleton of the system is apparent but there is not sufficient topographic data to permit making "office surveys" of the various alignments, it is sometimes necessary to fall back on the venerable technique of the "whoop-and-holler," particularly in wooded or bushy country. Usually, in staking the alignment of a gravity line it is necessary to take into account both the probability of a future extension up-stream, and accessibility to the line for connecting laterals down-stream. From both considerations, it is important to get the survey into a draw or creek bottom as soon as possible and to keep its alignment as low as is consistent with good construction practice. Most main gravity lines will meander with the course of a creek bed, but it is poor construction either to make repeated creek crossings or to throw an excessive number of side-bends in the line.

In order to minimize these two evils, the party chief picks his way down-stream along the best alignment he can choose until he reaches a spot where a side-bend will be required to prevent the line from either climbing out of the drainage or making a bad creek crossing. Here he stands, "whooping," until an answering "holler" from the instrumentman informs him that the transit has been trained on the sound of his voice. Then, while the brush cutters are clearing out a sendero along this first tangent he will scout ahead to select the next hub point. A good sense of direction and of relative elevation is needed for this rough-and-ready form of surveying, supplemented by a clear baying voice, and the technique can only be learned in the field. The one general rule that can be given for running out gravity lines, "get them low and keep them low," has exceptions as illustrated in Fig. 2.

In the north-central part of Fig. 2, on the 48-ft contour, there is a field pump, supposedly serving the most southerly battery of the Escondido field, which lies off the map. In the southwest corner of the sketch is a small pool, producing

FIG. 2. Sketch of the area between Seco pool and the Escondido field, Mythical County, Texas.



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about 200 bbl per day, whose operator has requested a pipe line connection. Lacking a topographic map of the area, the Mythical engineer knows no more of the country than he can observe from the ground when his party unloads at the first lease tanks. It is quickly obvious that gravity lines from all four batteries can be brought together at the head of the little draw, marked "A" on the map, but where to go from there?

The course of Seco Creek offers a beautiful route for a main gravity system if only there was production to be gathered along its flanks, but this country has been thoroughly tested. There is no oil save in the small dome, and the problem is to get the oil by gravity flow and the most economical alignment into the field-pump at "C." A few moments sighting through the leveled transit confirms the impression of a blocking ridge that falls away toward the northeast. This situation, simple to fathom and solve on a contour map, is extremely irritating when encountered in the field by a man who is depending on the "whoop-and-holler" to get him home. He is aware of an approximate 50-ft static advantage between the lowest tank battery in the Seco pool and the suction of the field pump at "C," but there is the ugly fact of the intervening ridge to be surmounted.

Now, on a "perfect" gravity line there will be no points on the alignment that rise above the theoretical hydraulic gradient, usually imagined as a straight line connecting the tank outlet (as the lowest battery in the Seco pool) with the terminus (as the pump suction at "C"). Wherever the pipe line rises above this theoretical gradient there will be diminished pressure in the pipe, with a consequent diminished rate of flow. Neglecting siphon effect because of the probability of air in the pipe, the rate of flow is calculated as though it were produced solely by the difference in elevation between "A" and the ground at the so-called "control point," regardless of the fall between the control point and "C." In Fig. 2 it is obvious that the only way to avoid control points will be to skirt the ridge, somewhere about point "B." An alignment can be staked from "A" through "B" to "C" on which there will be no control points; it will be 23,500 ft long with a fall of 48 ft, giving a gradient of 2 ft per 1000 ft, and requiring more than twice the amount of pipe that would be used in a direct connection from "A" to "C."

Not having the information of Fig. 2, our man at "A" doesn't know what profile and gradient he will be able to get. If the ridge is wooded he will know nothing except that his direct route is blocked, and that the obstacle falls away toward the northeast. There will be an almost irresistible impulse to angle down the southeastern slope in search of a pass or saddle across the spur. He will allow himself to be forced farther and farther eastward, with repeated backing-up and revisions of the survey each time he attempts to cut back toward "C" and finds himself again going up-hill. I once wasted two days work of a seven-man party on just such an obstinate refusal to forget Daily Progress long enough to run a few strings of reconnaissance levels and find out what was happening to that ridge. There are times when Daily Progress is best served by shutting down the works for a little reconnoitering, and this is one of them.

By running a random stadia traverse from "A" out along the spine of the ridge, it would have been quickly apparent that there was no profit in going very far off the direct route, for the ridge would have to be reckoned with sooner or later and any advantage gained by crossing it at a lower elevation would be nullified by an increased length of pipe, which would reduce the effective gradient. Rough, experimental profiles could be platted from the elevations found by the traverse until a suitable compromise between economy of pipe and satisfactory gradient is determined. We can see that an elevation of about 82 would be found at point "E," and about 76 at point "D." On an alignment "A-D-C" the leg "A-D" is 11,500 ft long with a fall of 20 ft, giving a gradient of about 1.7 ft per 1000 ft and a total length of pipe of 16,300 ft. On the alignment "A-E-C," the leg "A-E" is 8500 ft with a fall of 15 ft, giving a gradient of about 1.75 ft per 1000 ft and a total pipe length of 12,500 ft. Hence, it is apparent that pipe is being needlessly wasted by crossing the ridge anywhere northeast of "E," and that if a gradient of 1.75 ft per 1000 is insufficient to give the required flow rate we had as well set a pump at "A" and lay a discharge directly from "A" to "C."

Situations such as the above frequently will occur. They emphasize certain remarks made in a previous article on pipe line surveying concerning the danger of too great a devotion to the demands of Daily Progress. Pipe line work requires speed, but there are, constantly, occasions when a little time spent in looking about, in turning aside for some oblique reconnaissance, is more effective than a frantic activity that means only repeated revisions in the line. ★ ★ ★

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Analyses of 192 foreign crudes show sulphur content of over 4 per cent in crudes of Chusovski, Russia; Kuchova and Patos, Albania; Gonzalo, Topila and Zurita, Mexico.

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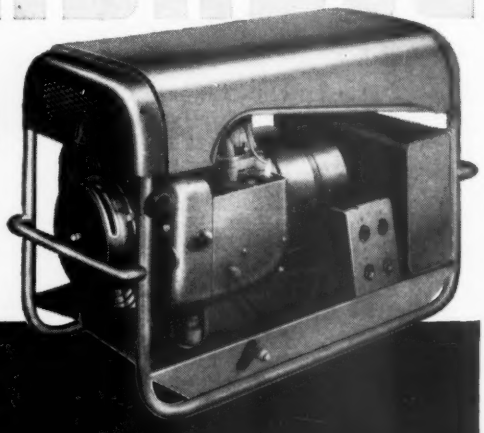

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Application of the shaped-charge process to petroleum production*

By ROBERT H. McLEMORE, Welex Jet Services

● **Abstract.** Prefacing the remarks with a brief discussion of the history and theory of shaped high-explosive charges, the author discusses the application of this phenomenon to the perforation of oil-well casing and the penetration of formation below the casing seat.

The knowledge of the penetrating effect of high-explosive charges with a cavity in their forward end was first disclosed by Professor Charles E. Munroe in the 1880's. This phenomenon, known since that time as the "Munroe effect" or "the cavity effect of explosives," is created by hollowing out the end of the high-explosive charge which is facing the object to be penetrated. Upon detonation of the charge, an indentation will be made on the object—the diameter of which will be roughly equal to the diameter of the hollowed-out portion of the charge, and the depth of which will vary increasingly with the depth of the hollowed-out portion. Some practical use of this principle was made during the ensuing years but, generally speaking, the phenomenon, although an interesting one, appeared to have no widespread value.

As a result of research work done in the field of high explosives, it was determined that tremendous changes could be made in the penetrative characteristics of the hollow-charge effect by inserting a metal liner into the hollowed-out portion of the explosive, and by moving the charge away from the object to be penetrated. Introduction of these two factors into the already known principles of the hollow charge resulted in a small round entrance hole in the object to be penetrated, which tapered down gradually to a relatively great depth (Figs. 1 and 2). It was found that the material that comprised the liner, its size, thickness, and shape, together with the distance between the base of the liner and the target, all had a bearing on the diameter of the entrance hole into the target, the amount of its taper, and the total amount of penetration. Innumerable tests proved that a conical liner of copper or steel would effect the greatest penetration, provided the apex angle of the cone was small enough and the material thick enough to prevent its extroversion upon detonation. Liners of other materials, such as glass or aluminum, will produce holes of greater diameter and less depth. Liners of other shapes, such as hemispherical, will produce holes with different characteristics.

Due to the extreme rapidity of the reactions involved in the detonation of the lined shaped charges, it has been difficult to determine all the causes and effects that are a part of the phenomenon. Many high-speed X-ray photographs of the charges in the process of detonation have been taken, and from these a vast quantity of research data has been accumulated. As yet, no full explanation of the many complex physical and chemical reactions involved in this process is available to the public. The following is an approximate theoretical interpretation of the phenomenon (Fig. 3).

The detonation wave, which must be initiated from a point on the extended axis of the cone or liner, starts traveling downward toward the apex of the cone. As it reaches the apex and progresses toward the base, the cone is collapsed radially, symmetrically, and inwardly. As the walls collapse and meet along the axis of the cone, the pressure along the axis, due to the impact of the collapsing walls, is increased to a point above and beyond the pressure generated by the detonation wave. During the collapsing process the material comprising the inner layers of the liner, due to the high pressures and temperatures, has become highly plastic. Because the gases are continuing to exert pressure at the rear of the liner, the only avenue of escape for this plastic material is through the small aperture left in the forward section of the rapidly collapsing liner. Because the jet escapes the confines of the collapsing liner, emerging from the forward end of the liner in the form of a long pencil-like stream, it can be assumed that it travels at a velocity greater than the approximate 8000 meters per second velocity of the detonation wave. Following the jet, at a much lower velocity (approximately 500 meters per second), is the "carrot," which consists of that part of the cone or liner that has not been converted into the particles to form the jet, and which has now collapsed into a thin elongated shape resembling the vegetables from which it

*Presented before Twenty-seventh Annual Meeting of the American Petroleum Institute, Chicago, Illinois, November 11, 1947.

FIG. 1. Showing penetration in steel target from shaped charge without liner.

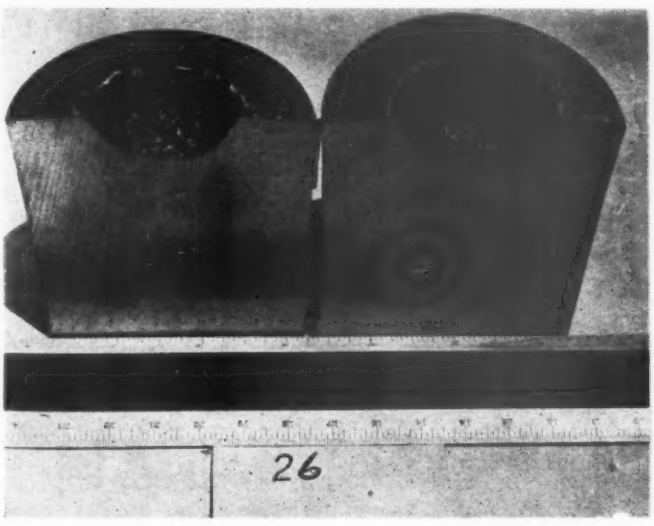
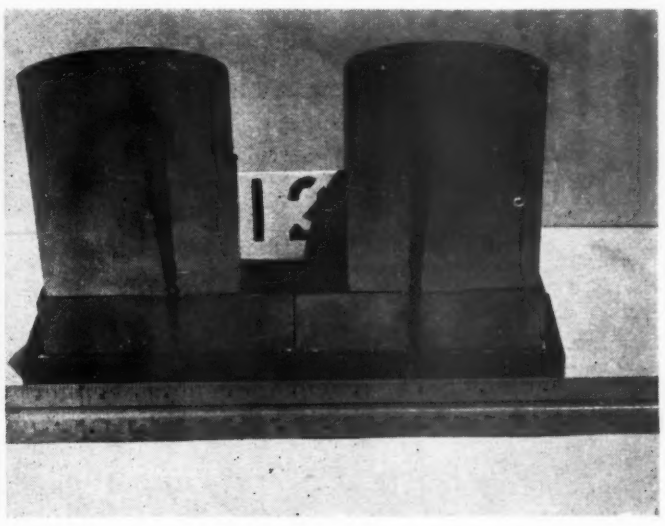


FIG. 2. Showing penetration in steel target from shaped charge with liner.



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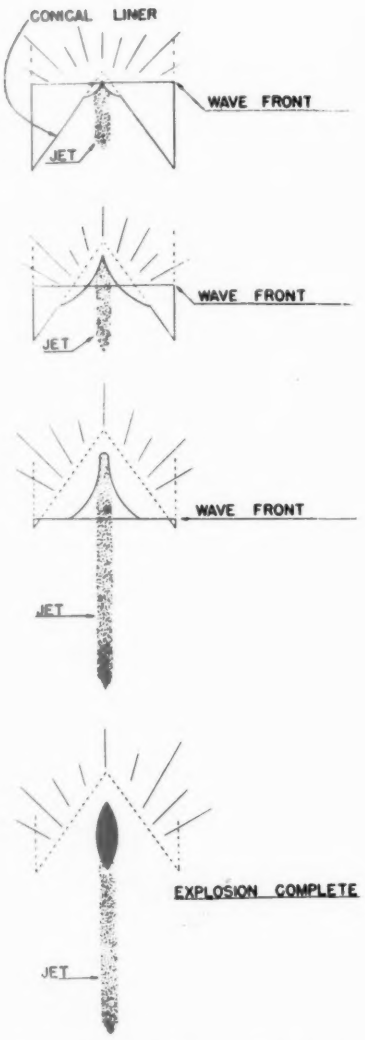

FIG. 3. Diagrammatic sketch of conically lined shaped charges.

derives its name. The "carrot" does not originate the hole in the object that serves as the target; it merely follows into the hole that has been made previously by the jet. To get this penetration from a lined shaped charge, and to give the forces involved sufficient time and space to form into an efficient jet, the factor known as "standoff distance" is quite important, and must be considered. This may be defined as that distance from the base of the liner to the first obstruction that the jet will strike. This standoff distance varies with the shape, material, and thickness of the liner, in order to allow the gases and metal particles to form into an efficient jet.

The uses of these principles in projectiles, and rockets, in World War II are comparatively well-known, and are not a topic of this discussion. It is the adaptation of these principles to the production of oil and gas that is of immediate interest to us.

For the past few years an active research and development program has been conducted on the adaptation of this principle to its readily apparent uses in the production of oil and gas. The problems of developing a charge that must necessarily be small enough to go inside of well casing, of developing a means of detonating these charges in multiple, with no interference from adjacent charges, of finding a vehicle to contain the charges that could be withdrawn from the hole and used again, of eliminating damage to the well casing when the charges are detonated, of finding an explosive that would be safe to handle and sure of detonation under the high temperatures that are encountered in the oil wells of today, have been met and solved successfully; so that adaptation of the lined shaped-explosive-charge principle to petroleum production, although by no means complete, is advanced to the stage where its use is an established fact. Active work has been conducted on several applications of the principle to oil and gas production, including casing perforating and open-hole blasting or formation penetration.

● **Casing perforating process.** Two sizes of charges have been developed for use in casing perforating operations at this time, both being of the "beehive" or tapered form of charge with a cross-sectional area that decreases from the base of the liner to the point of initiation (Fig. 4). Each charge is contained in a molded bakelite case, and is equipped with a steel cavity liner—the liner being placed sufficiently far back into the case to give an adequate standoff distance. The 28-gm charge is designed for the perforating of 6⅝-in. OD casing, and larger, and is fired from a carrier that is 5 in. OD. The 21-gm charge is designed for the perforating of 5½ in. OD casing, and is fired from a carrier that is 3⅜ in. OD. (Fig. 5). The charges have a copper ferrule inserted through the initiating end for the threading of the detonating fuse. The 24-shot carrier is of heavy tubular design, with ports through which the jet will pass placed in it on 3-in. centers at 120-deg phasing. The charges, after having the prima-cord detonating fuse threaded through the ferrules on the initiating ends, are inserted in the carrier and securely fixed in position in alignment with respective ports. The ports, of course, are externally sealed to exclude the well fluids and pressures. The free end of the prima-cord is brought up through the top of the carrier to the detonating sub, where it is connected to an electric blasting cap that, in turn, is connected by means of conductor cable to the surface operating truck, and which is initiated in the conventional manner. Upon detonation, the shaped-charge jet shoots through the port seal, through the well fluid, through the casing and cement, and into the formation. Inasmuch as the single length of prima-cord initiates all the charges, and the rate of detonation is approximately 22,000 fps, the detonation of all the charges is virtually simultaneous.

FIG. 4. Casing perforating charges.

The 28-gm charge will make a hole approximately ½ in. in diam in the casing, and the 21-gm charge will make a hole approximately ⅜ in. in diam in the casing. These hole sizes can be made larger or smaller by varying the dimensions of the liner and the charge; but at this time, because of the production problems involved, only the two sizes are being used. Both sizes of charges have been designed to give approximately the same amount of penetration, the additional energy represented by the larger amount of explosive in the 28-gm charge being expended in making the larger diameter hole. A penetration in mild-steel plate of 4 in. to 4½ in. will be obtained with either of the charges; or, translated into oil-well terms, a hole through a section of casing and 6 in. to 9 in. of cement will be opened. This variation in penetration is a function of the fluids through which the jet must pass before striking the casing. In perforating casing, the carrier will usually lie along one side of the pipe, so that some of the jets will have the maximum distance between the carrier and the walls of the casing. Further studies have been made of the effect on penetration when the path is not normal to the casing. Due to the usual nonconcentricity of the carrier within the casing, it can be assumed that many of the jets strike the walls of the pipe at some angle other than perpendicular to the tangent. It was ascertained that, due to the extreme high velocity, there was no tendency for the jet to be deflected, and that there was no noticeable decrease in the overall penetration obtained.

The passage of the jet through the casing causes a flow of metal to the inside of the casing, resulting in a "burr." These burrs have been found to protrude between 1/64 in. and 1/16 in. from the inner wall of the casing.

A study of the effect of the shaped-charge jet on the cement in the annulus has revealed that there is little or no tendency for the cement to shatter or crack, even after prolonged setting periods; and it appears that the practice of perforating cement at predetermined age and strength, in order to eliminate the formation of cracks or fissures that will cause future trouble from gas to water, will not be necessary. There is a tendency for the jet to form a small "pocket" in the cement adjacent to the outer wall of

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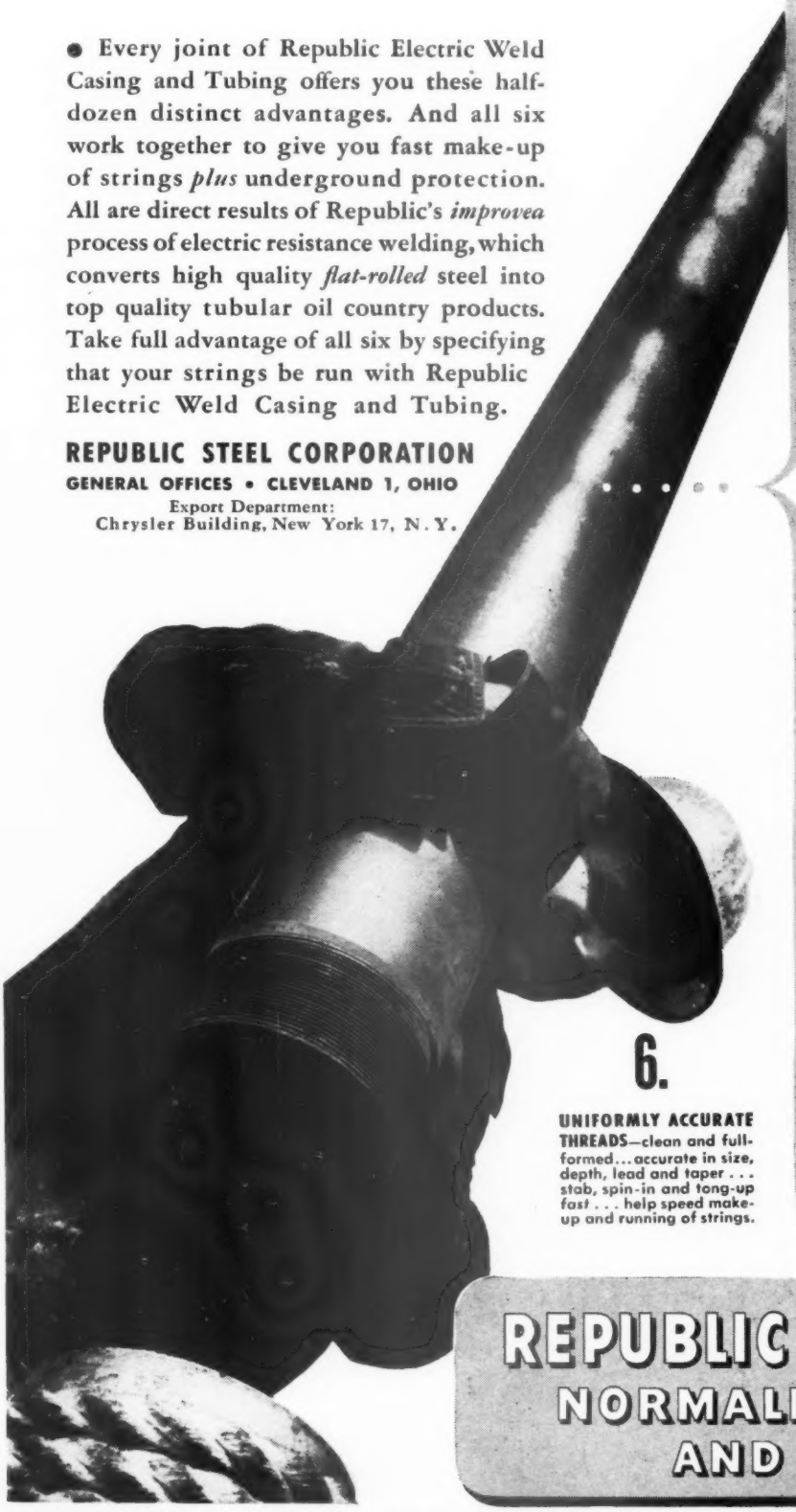

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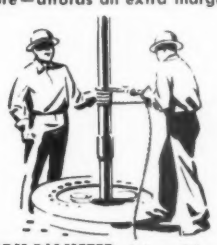

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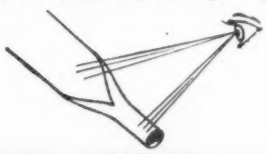

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the casing. The size of this pocket varies with the age and strength of the cement, and is formed whenever the jet passes through one medium into a softer material. In the perforating of multiple strings of casing, the "pocket" is formed on the outside of each string. Its average size in 21-day-old cement will be about ¾ in. in diam and 1 in. in length.

All tendency toward the splitting or damaging of the casing during perforating operations has been eliminated. Exhaustive tests with many grades and weights of pipe have been conducted under what are considered to be extreme conditions, resulting in no splitting or bulging. The tests were made with both 5½-in. OD and 7-in. OD pipe nipples of various grades and weights, 8 ft long, open at both ends, and unsupported under a 6-ft head of fluid. The charges were fired under a 6-ft head of fluid, because a low fluid head constitutes a more severe test than a high fluid head. The pipes were pierced to a perforating density of 12 shots per ft, many of the holes being within 1 in. of each other. No splitting was encountered.

The jet effect from a shaped charge can be obtained, to some degree, with the use of almost any high explosive. Commercial dynamite has been used, as has nitroglycerin, and both powdered and cast TNT. However, in order to obtain the best results, i.e., maximum penetration, it has been found that an explosive with a high brisance or velocity of detonation, together with a high acceleration of detonation, is necessary. The commonly used explosive in military projectiles was known as pentolite (a mixture of TNT and PETN),* which was poured into the projectile in a liquid state and passed into the solid state upon cooling with a density of 1.6. Pentolite has all the qualities necessary for efficient shaped-charge operation, i.e., relative insensitivity to shock, high energy content, and high velocity of detonation (7500 meters per second); but for oil-well use it has the unsatisfactory feature of a low melting point (180 F). It was necessary that an explosive be developed that would contain the desirable features of pentolite and that would withstand the high temperatures encountered in the deep oil wells of today. When loaded at high density in casing perforator charges, the explosive finally chosen is relatively insensitive to shock; has a high rate of detonation, a high energy content; will burn without detonating, and is sensitive to prima-cord detonation only when the prima-cord is threaded through the end of the charge designed for its entry. In addition to these features, it is designed to withstand a temperature of 325 F for 24 hrs and a temperature of 350 F for 1 hr. If excessive temperatures are encountered, it will fume off into a gas—excluding all possibility of premature or unwanted detonation due to high temperature. These qualities, together with the insulating property of the hollow tubular carrier, make the explosive entirely feasible for use at any well temperature encountered to date (Fig. 6).

*Pentaerythritol tetranitrate.

FIG. 6. The "carrot"—the portion of the metal liner that has not been converted into small particles that assist in the formation of the jet.

FIG. 5. Casing perforating charge carriers.

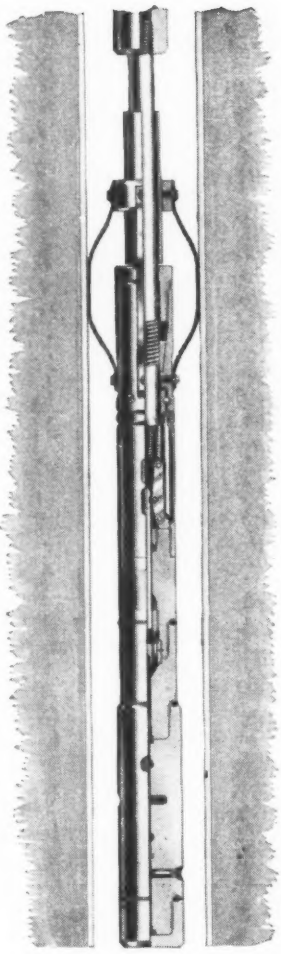
● **Open-hole blasting.** This phase of the shaped-charge process is still considered to be in the experimental stage of its development. The shaped charges used are of the same basic design as the casing perforating charges, but are larger—designed to produce holes of a greater diameter and a greater depth of penetration. The practical application of this phase of the process is the penetration of a sufficient distance back into the formation of producing wells that show a decrease in production due to a clogged congested sand condition, and to create crevices through which trapped well fluids may flow. It is even more adaptable to wells which are to be treated with acid, in that it will establish holes some distance back into the formation and create a much greater area of clean formation on which the acid may work.

● **Conclusion.** It is confidently expected, as a result of the active research program being conducted on this process, that refinements and improvements will be developed, and additional applications will be derived such that, before the adaptation of the principles of shaped charges to petroleum production can be considered complete, it will have proved to be a valuable asset to the more economical production of oil and gas, and a means of securing a greater ultimate recovery.

● **Acknowledgment.** The author wishes to acknowledge the direction and participation of Robert T. Harcus of Byron Jackson Company, Los Angeles; Eugene O. Tolson and Henry H. Mohaupt of Well Explosives, Inc., Fort Worth. The explosive composition and the casing perforator charges containing it are developments of E. I. du Pont de Nemours and Company, of Wilmington, Delaware, the charges having been developed with the assistance and cooperation of the aforenamed individuals and organizations. Fig. 3 was taken from the paper "Studies of the Design of Shaped Explosive Charges and Their Effect on Breaking Concrete Blocks," by George B. Clark, American Institute of Mining and Metallurgical Engineers, March, 1947.

Approval for the presentation and publication of this paper has been given by the U. S. Army Ordnance Department.

* * *

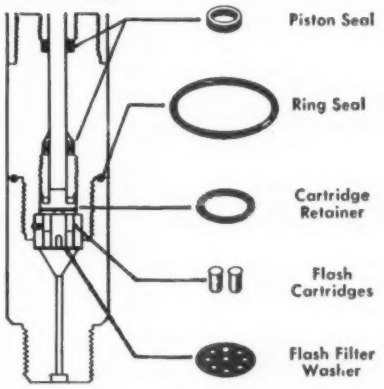


A JOHNSTON SHOOT-N-TEST GUN PERFORATOR

Uses only these few expendable supplies...

THE FEW EXPENDABLE SUPPLIES illustrated are *all* that are needed for each Johnston Gun Perforating Job. After cleaning and drying the Firing Head and Perforating Gun Section, these few parts are easily replaced during normal reassembly. Individual Firing Chambers of each 4, 5 or 6-shot Perforating Gun Section are hand-loaded and need only a light portable hydraulic capper to assure precision alignment of the retaining cups over the firing chambers.

The Firing Head of the Johnston Gun Perforator requires no special tools or fixtures to effect complete reassembly. The Sealing Rings, Piston Seals, Flash Washers and two 32-calibre cartridges are negligible in cost and can be replaced right on the rig floor. Belly Springs need be replaced only when friction-worn beyond their ability to hold tension. Tension can be re-set before each run.



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Before you purchase any Gun Perforating Equipment check the outstanding advantages offered by the Johnston All Purpose Gun Perforator!

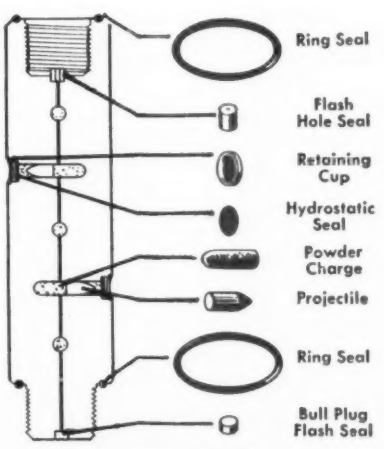
PERFORATE AND TEST IN ONE TRIP! To *both* perforate casing and test formation in one trip of tubing or drill string you simply connect the Johnston "SHOOT-N-TEST" Gun Perforator to your regular Johnston Tester and Pressure Recorder. First you fire the Gun Perforator and then take a formation sample immediately after perforating casing.

***SAFE* GUN PERFORATOR OPERATION!** The Johnston Gun Perforator affords utmost safety in all phases of gun perforator operation. It will not fire until subjected to both in-the-hole hydrostatic pressure and top-hole manipulation by the driller.

PORTABILITY AND FLEXIBILITY! The Johnston Gun Perforator can be transported in the back of your regular field car! And *after* arriving at well location, you attach only the number of 4, 5 or 6-shot Perforating Gun Sections needed for that particular job.

EXACT POSITIONING IN PRODUCING ZONE! Accurate placement of the Johnston Gun Perforator opposite the zone selected for perforating is easily determined by your own pipe-in-the-hole tally. No rigging up of special measuring devices is necessary.

POSITIVE FIRE OF ALL PROJECTILES! The safe, fool-proof hydrostatic firing principle of the Johnston Gun Perforator Firing Head coupled with the flash-hole design of the Perforating Gun Sections insures positive fire of all projectiles.



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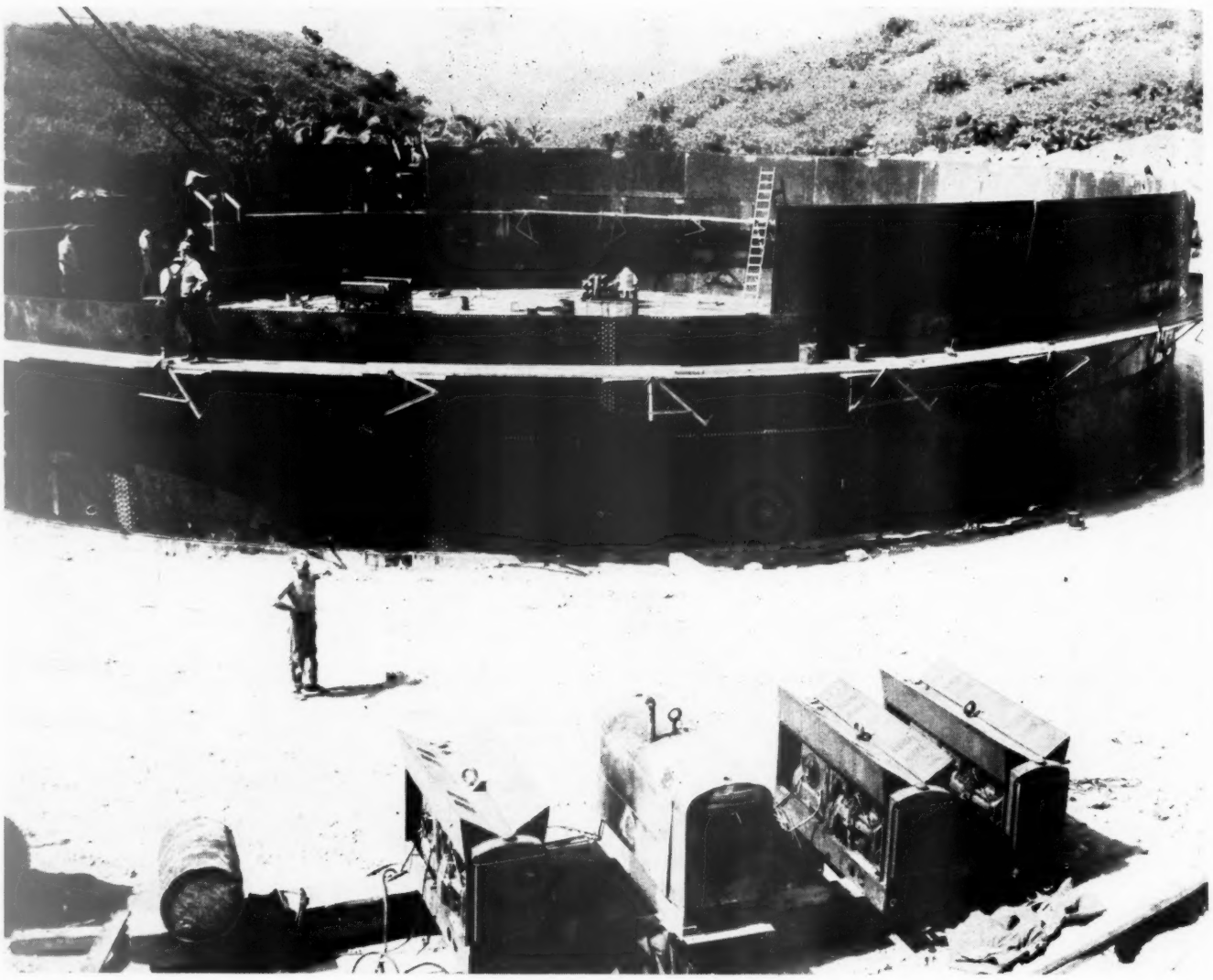


Two and a half up, three and a half to go! Tank looks like huge swimming pool. Four welding machines seen in foreground.

Storage tank construction on Guam

By TOM RICHARDS

EXCLUSIVE

THE recent war struck Guam of the Mariana Islands with the full impact of its devastating fury. When the fighting was over nearly all the military installations on the island were destroyed and roads, pipe lines, tanks, and many of the villages, including the city of Agana, were demolished. The United States government issued contracts for the rehabilitation and construction of military and civilian installations on Guam.

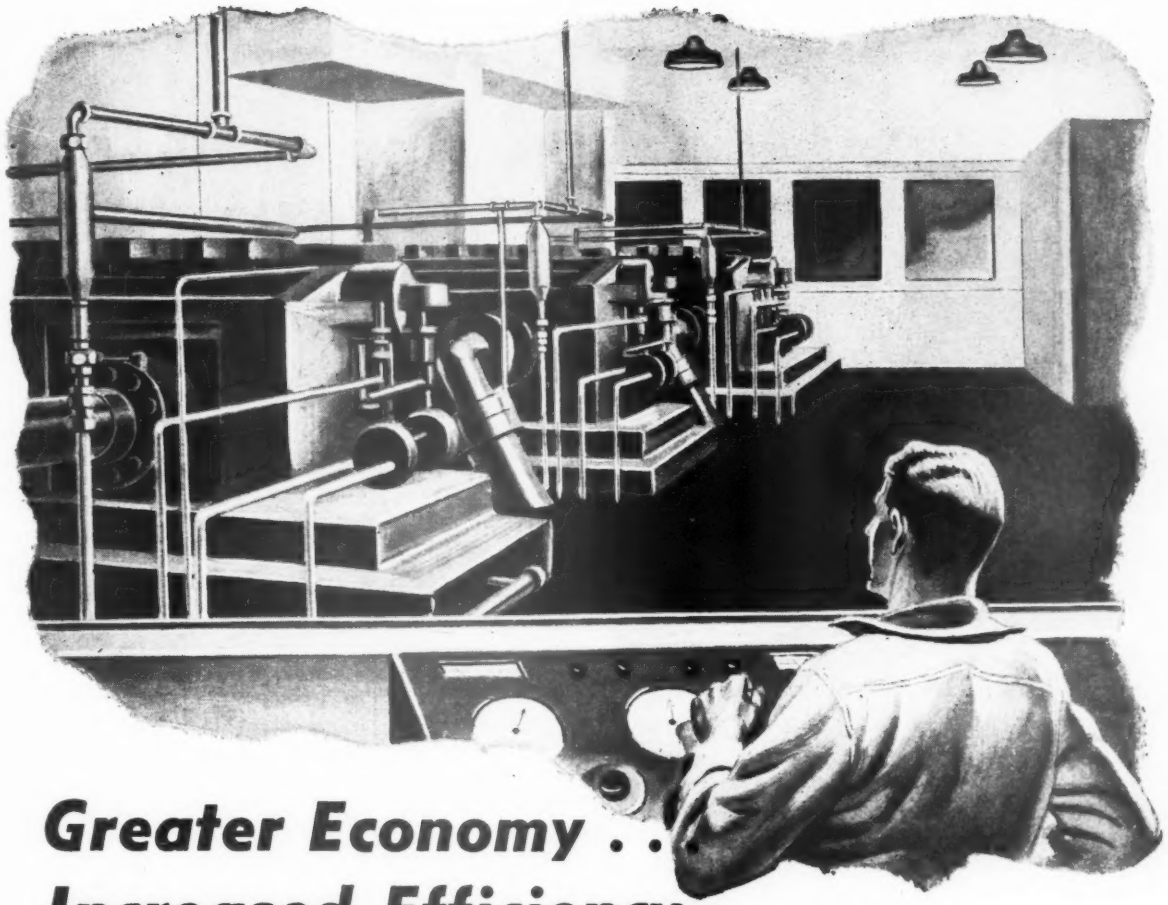
Some of the contractors who received Bureau of Yards and Docks Navy contracts are Brown-Pacific-Maxon, NOy-13931, general contractors; Guam Dredging, NOy-13496, dredging and engineering; Pacific Islands Engineers, NOy-13626, architects and engineers for the design and construction of the post-war program for the island of Guam, Mariana Islands.

The rehabilitation of bomb blasted or corroded fuel storage tanks and the erection of new tanks on Guam has been a major undertaking. It has been a hard rough tough job and among the toughest is the job that fell to the lot of the Brown-Pacific-Maxon tank crew, which completed its work on its scheduled time and is to be commended for its splendid workmanship and efficiency.

The job assigned to the tank erection department was especially rugged not only because of the rough and hard-to-get-at tank sites but also because much of the work had to be done with used materials. It is, of course, much more difficult to erect tanks out of used materials than it is from new materials. Some of the tanks had been erected and knocked down several times and the iron was old, rusted, and distorted.

Some idea can be had of the size of the job by the following list of materials and work involved in the erection of just one tank of 4,440,000-gal capacity:

Steel	295,000 lb
Welds	3,800 lf
Welding Rod	8,000 lb
Hot rivets	22,640
Cold rivets	6,400
Work per hour units	8,320



Greater Economy . . Increased Efficiency in Pipe Line Operations with LOW-COST ELECTRIC POWER

Experience gained in construction and operation of new pipe line systems proves and justifies the trend to larger diameter lines, fewer pump stations, and simplified pumping equipment. Low-cost electric power enables you to attain the fullest economy in application of these three factors. Motor-driven pumps require less initial investment . . . less maintenance expense . . . and less for operation and labor. A minimum of attention and supervision is necessary when you have "pushbutton control" of your pumping equipment.

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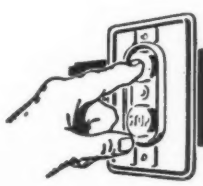
Electric Power offers you



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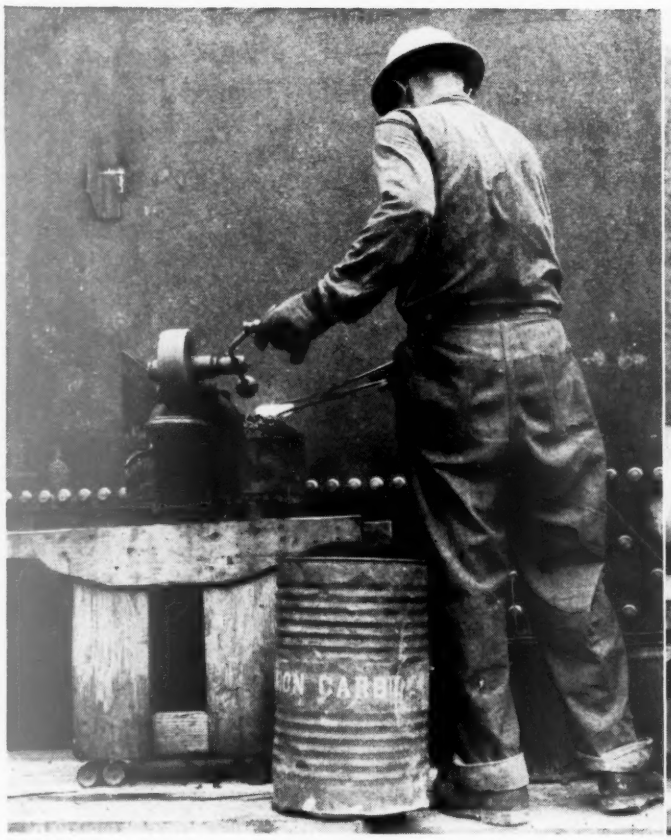
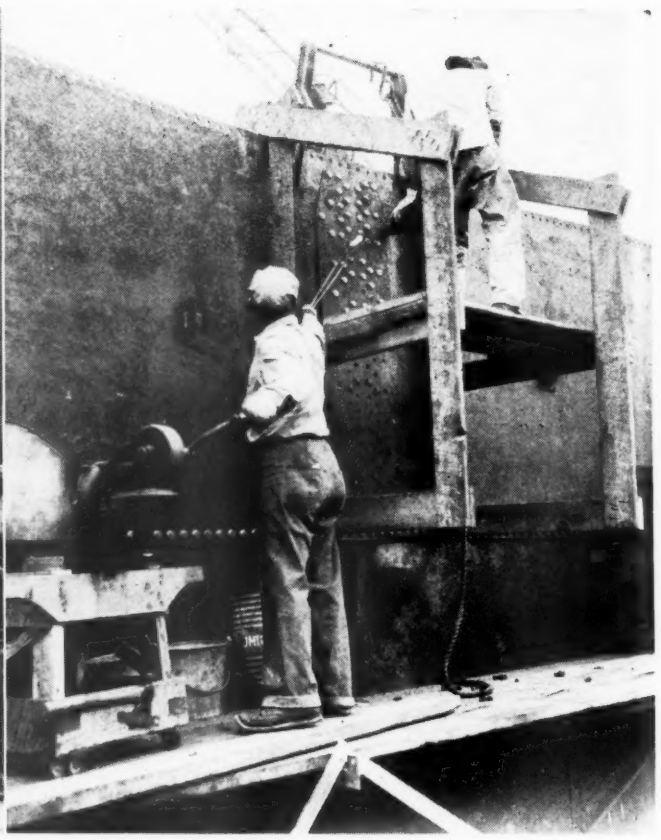


A tank goes up no faster than the rivets are supplied to the bucker. This portable forge assures a plentiful supply of hot rivets without time-consuming movements.

The bucker shoves a white hot rivet through the tank wall and the riveter prepares to cap it immediately.



A hot rivet is set in place and is waiting for the riveter to hit it with his gun. The boys drive one rivet every 11 seconds, working together in practiced unison.

Welder works high on the side of a tank and it will not be long before another needed tank is completed.

Dimensions:
Diameter, ID ..... 117 ft 8¼ in.
Height ..... 47 ft 3⅝ in.

This particular tank was fabricated in 1918 and first erected in 1919. This is the fourth time it has been erected. When the tank was erected this time it looked like, and is, just as sturdy as a brand new tank.

Doing their share of jobs like the above is just routine for the Brown-Pacific-Maxon tank crew. Blackie Acosta was the superintendent, Dutch Holford the general foreman, and George Chambers and Les Greer the foremen.

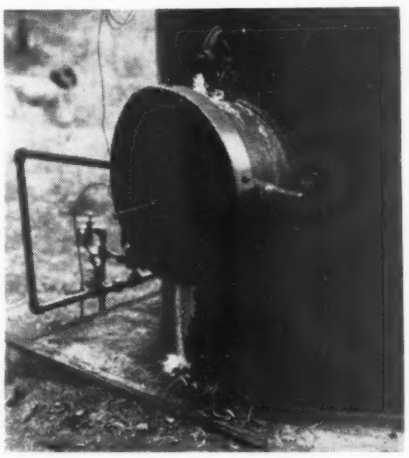
The grading and paving department, under the supervision of C. S. Thaxton, excavated the tank sites and built the access roads.

The men, fighting mud and jungle in all kinds of weather, driving tropical rain storms, and blistering heat, have had to walk narrow scaffolding high in the air where a slip would mean instant death.

The job was completed with an excellent safety record, which depicts the kind of cooperation that Blackie's men have given the Brown - Pacific - Maxon safety department. * * *

BURNER COVER

Wind blowing directly into the burner of a heater on a lease in a low spot where the land acted as a funnel to direct the blast resulted in the fire being extinguished frequently. To prevent this a cover was made from ¼-in. tank plate. A disk, overlapping the face of the burner by 2 in. all around, was fitted with a 3-in. rim. The cover was bolted over the



burner so there was a clear space of 1 in. between plate and burner.

An opening in the plate covered with a pivoted piece of light steel served as an inspection orifice. The opening also made it possible to observe the fire as it was lighted.

Combustion air was drawn in around the flanged rim, through the 1-in. space, and finally through the butterfly aperture in the burner shell.

The cover improved draft regulation and reduced corrosion of the burner by protecting it from rain. * * *

Simplify valve selection with this
LUNKENHEIMER
"RENEWO" THREESOME...

The "RENEWO" Threesome is fully described in Circular No. 577, which also explains the economy feature of converting one type to another by simply changing seat and disc. A copy is yours for the asking . . . from your Lunkenheimer Distributor or from us direct.

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1 "REGULAR TYPE..."

Fig. 73 200 lb. S.P.
Fig. 16 300 lb. S.P.

Regular "RENEWO": one of the most popular and widely used valves ever designed for general service. As the name clearly implies, all parts are renewable.

2 "P" TYPE...

Fig. 73-P 200 lb. S.P.
Fig. 16-P 300 lb. S.P.

"P" (Plug Type) "RENEWO": for throttling, drain, drip, water column blowdown and similar service. The "NS5" Nickel Alloy 330 Brinell seating material, developed and patented by Lunkenheimer, has exceptional wearing qualities and high corrosion resistance.

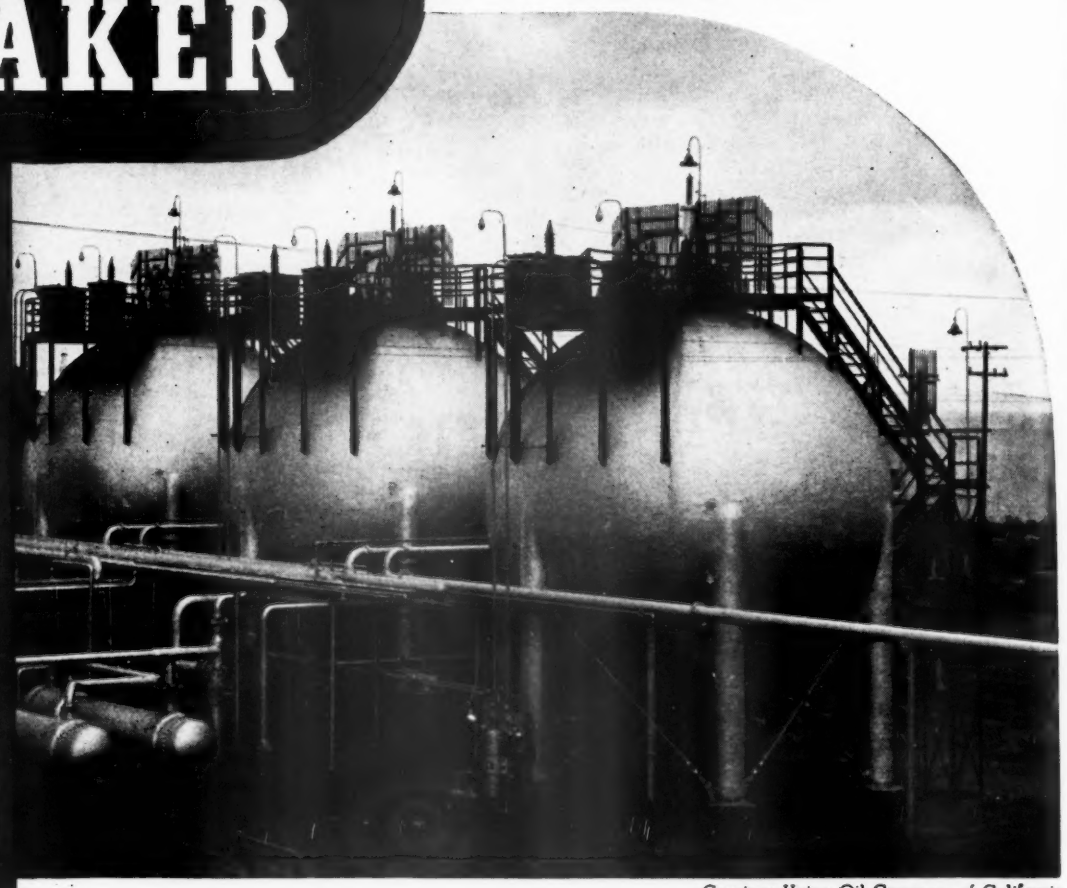
3 "PS" TYPE...

Fig. 73-PS 200 lb. S.P.
Fig. 16-PS 300 lb. S.P.

"PS" (Plug Type) "RENEWO": for maximum resistance to the effects of close throttling and other severe service, particularly where abrasive conditions are encountered. Equipped with stainless steel 500 Brinell seat and disc.

SALT SHAKER

...NG SIZE...



Courtesy Union Oil Company of California

A Petreco Electric Desalter doesn't exactly *shake* out the salt, but it sure gets rid of it–right now. Most Petreco desalters are getting 90% or better removal–98, 99 and 100% removal efficiencies are not unusual. Desalting eliminates the nuisance of frequent refining shut downs caused by salt plugging, hard coking and HCl corrosion. Desalting insures greater capacity, longer runs, and smoother operations. If you're having any salt difficulties, get in touch with us. We've helped some mighty good refining men shake the salt problem out of their hair. *The Petreco process is not expensive;* a Texas refiner recently figured his Petreco desalter paid off in less than six months. Get in touch with a Petreco engineer–he'll show you the figures!

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Measuring liquid level in vessels under pressure

By C. F. CUSICK* and S. D. ROSS

Brown Instrument Company

MODERN industrial processes often require the measurement of liquid level in containers under pressure above atmospheric, usually as a basis for automatic control. The differential-pressure type mercury manometer, as commonly used in flow measurement, is widely employed for such service, because it is ideally suited to measure the difference between the static pressure in the vessel and the pressure resulting from the column of liquid. Use of flow meter manometers for such liquid level applications has the following advantages:

(1). Standard production items available for working pressures up to 5000 psi.

(2). Available with electric or pneumatic remote transmission.

(3). Can be supplied with all the various modes of control, such as on-off, proportional, and proportional plus reset.

(4). Identical components as employed in the differential pressure type flow meters, thereby simplifying parts stocking and maintenance.

To handle the various liquids, a number of piping arrangements and connections to the meter body (manometer) are necessary; each type is discussed separately. On all closed vessel installations, placing of the meter body below the minimum level tap is recommended. This simplifies the instrumentation in both installation and maintenance. The connecting lines run downward to the meter body and are easy to fill. In addition, entrained air or gas will work up freely into the vessel or seal pots.

When necessary, the meter body can be mounted above the pressure taps, but in placing the equipment in operation, the engineer must be careful to ascertain that the piping is completely filled with liquid. Furthermore, he must frequently check that the piping remains filled with liquid free of entrained air or other gases. Such applications must be considered individually by experienced instrumentation engineers.

Both the Brown electric type meter body and mechanical meter with "dropped" range tube (described herein) can be utilized for liquid level measurement in the differential pressure ranges from 20 in. to 25 ft of water. The same operating principles are employed for both types of manometers and apply, in general, for all closed vessel service. A general discussion of these principles will form a background for the specific system subsequently described.

● **Fundamental principles.** Schematic layouts for the electric and mechanical type meter bodies are shown in the two views of Fig. 1. With the liquid in the vessel at minimum level, the meter body is subjected to a differential pressure equivalent to the head H_4 in the outer leg; the vessel pressure and the head H_2 are seen to cancel out, being applied on both sides of the meter body. As the level rises in the vessel, this differential pressure decreases to zero at the maximum level connection. Such a relationship is seen to be directly the reverse of that found in flow measurement where the differential pressure increases with flow, and accounts for the methods of connecting the electric and mechanical meters, as shown in Fig. 1 and explained below.

In the case of the electric meter, it is only necessary to reverse the outer (power) leads of the inductance bridge circuit to reverse the response of the meter. Thus, the float chamber (high pressure) side of the meter body can be connected to the outer leg, as illustrated, but the instrument will read zero level when the vessel is empty and respond in the normal manner with level changes, the float moving upward for increasing level.

In the case of the mechanical meter, reversal of the instrument response is accomplished by "dropping" the range tube below the float chamber and connecting the latter to the minimum level tap, as shown in Fig. 1. Thus, the float is in its normal upper position for minimum level and moves downward with increasing level (decreasing differential), just as it moves downward with increasing flow when a standard mechanical meter is used in the conventional manner. The dropped range tube provides the necessary chamber for mercury displaced from the float chamber as the level rises.

For the development of the basic formula to calculate the required differential range of the meter body, it is assumed that the specific gravity (G_1) of the liquid is the same in the connecting piping and the vessel. The equation for the balanced columns (Fig. 1) is, then, as follows:

$$13.54\ h + H_2G_1 = (H_4 + H_1)\ G_1$$

but the linear distance H_1 equals the distance $H_2 + h$ and H_4 equals H, so that by substitution for H_1 and H_4 these equivalents and solution of the equation for h, the following basic formula is obtained:

$$h = \frac{H\,G_1}{13.54 - G_1} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

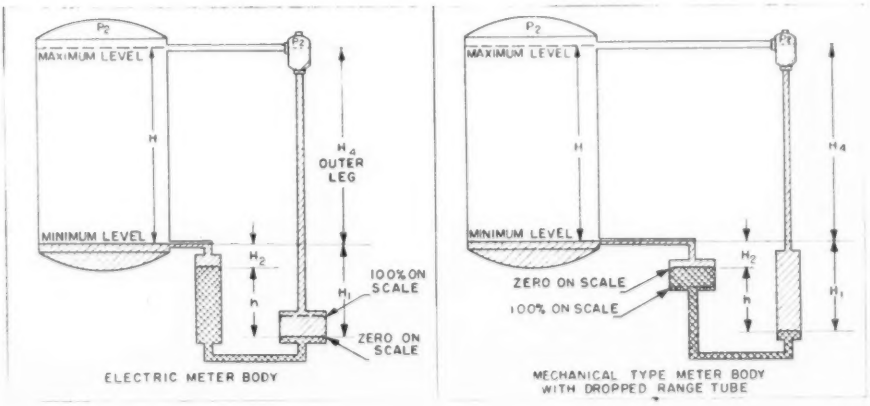
Where:

h = differential in inches of mercury,
H = distance between taps in inches,
G_1 = specific gravity of the liquid.

It is interesting to note that the range of the meter does not depend upon the pressure in the vessel, so that the operating pressure can be altered as desired without affecting the level measurement.

● **Vessel liquid.** For liquids that are free of entrained particles or solid forming matter and which can be placed directly in contact with the mercury and material of the meter body, the piping arrangements shown in Fig. 2 can be used. There are two general applications of this system, both using the same piping layout, namely: (1) When the liquid in the outer leg is at the same temperature as the vessel liquid (usually ambient), and (2) when the outer leg liquid is at a different temperature from the vessel liquid (usually lower, with the

FIG. 1. Basic installation diagrams for differential pressure type meters used to measure liquid level in vessels under pressure.



*Mr. Cusick is application engineer and Mr. Ross is chemical engineer for Brown Instrument Company, Division of Minneapolis-Honeywell Regulator Company.

vessel liquid at an elevated temperature).

● **Operating principles.** A reservoir is installed at the maximum level tap, as shown, so that there will be no appreciable change in the height of the outer leg as the mercury in the meter body moves from one side to the other with changes in the liquid level. When the liquid in the outer leg is at the same temperature as the vessel liquid and, consequently, has the same specific gravity, the basic formula (1) developed above is seen to apply. A lower temperature in the outer leg, however, results in a greater specific gravity, which must be considered in the formula for the measured differential, as developed below.

Let G_2 represent the specific gravity of the liquid in the outer leg H_4 (Fig. 1). With the vessel liquid at minimum level, the equation for the balanced columns now becomes:

$$13.54h + H_2 G_2 = (H_4 + H_1) G_2$$

By substitution for H_1 and H_4 as in the previously developed basic formula (1). the following formula is obtained:

$$h = \frac{H G_2}{13.54 - G_2} \quad \ldots\ldots \quad (2)$$

A comparison of this formula with the basic formula (1) indicates that the differential range of the meter in this case must be greater by the amount $H \times \frac{G_2}{G_1}$ because of the greater specific gravity in the outer leg. The scale or chart range of the instrument will thus be greater than the vertical distance between taps. The sample calculation considered below will point out the effect of this characteristic on the selection of the instrument chart or scale.

● **Sample range selection.** Assume that it is desired to measure the level in a vessel under the following conditions:

(1) Liquid in the vessel has a gravity of 70-deg API (based on 60 F) and is at a temperature of 250 F.

(2) The vertical distance between taps is 10 ft and a chart graduated 0-10 ft is desired.

(3) The vessel liquid is used in the meter body and connecting lines.

On all liquid level calculations, Brown engineers assume an outer leg and meter body temperature of 80 F, unless it is specifically given otherwise. For a 70-deg API liquid, the following applies:

70-deg API equals
- 0.702 specific gravity at 60 F
- 0.692 specific gravity at 80 F (G_2)
- 0.617 specific gravity at 250 F (G_1)

Thus, the range tube is designed for 10 ft of a 0.692 gravity liquid in the outer leg. With the vessel liquid at the minimum level, equation (2) provides the following:

$$h = \frac{10 \text{ ft} \times 12 \text{ in./ft} \times 0.692}{13.54 - 0.692}$$

$$= 6.463 \text{ in. of mercury}$$

With this differential, the instrument will read zero level, When the vessel liquid is at the maximum level. however, the mercury columns in the meter body will not be at the same levels, because the head of the outer leg (H_4) is greater than the head in the vessel between taps (H) by the ratio of G_2/G_1. The actual maximum meter range is thus:

$$10 \text{ ft} \times G_2/G_1 \text{ or } 10 \text{ ft} \times \frac{0.692}{0.617}$$

$$= 11.22 \text{ ft.}$$

The chart range of the instrument, therefore, is 0-11.22 ft instead of 0-10 ft, but the meter can never read above the 10-ft level, for any head above this point (the maximum level tap) will be exerted on both sides of the meter body and no further deflection will occur.

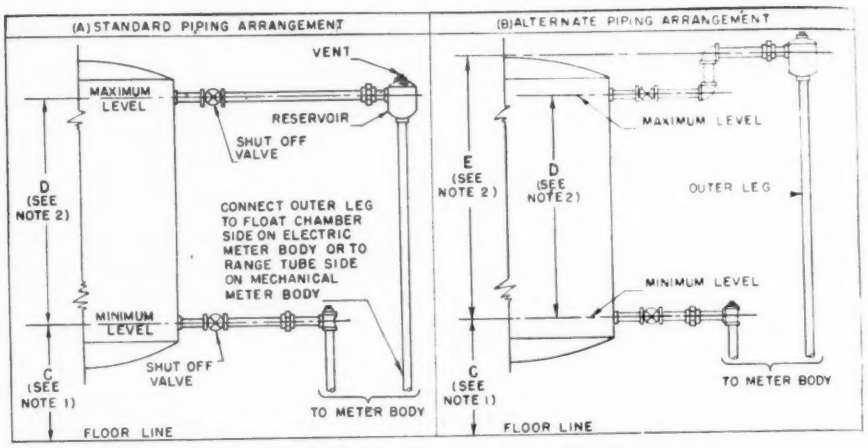
If it is desired to obtain a more uniform chart factor, such as a range of 0-12 ft instead of 0-11.22 ft, the alternate piping arrangement (B) in Fig. 2 can be used. The vertical distance "E" would be greater than the distance ("D") and is calculated as follows:

$$\text{"E"} = 12 \text{ ft} \times G_1/G_2 = 10.70 \text{ ft.}$$

The range tube would then be calculated for 10.70 ft of G_2 liquid and the range of the meter would be 0-12 ft.

If the meter is indicating only, an alternate procedure to the above is to make a "false" scale to eliminate the odd factor and, in effect, also avoid the increased range. For example, in the present problem, the actual range of the scale for the standard 1.2 in. travel of the float in the meter body is, of course, 0-11.22 ft; however, the printing on the scale could be made direct reading from 0 to 10 ft only. A mark would then be placed beyond 10 on the scale at the 11.22-ft point with the word "equalize" above it for calibrating purposes.

In either of the above methods, the meter does not read full scale when the



NOTE 1—Vertical distance "C" for installing meter bodies equipped with standard 3-valve manifolds, should be:

(1) Electric type—not less than 5 ft.

(2) Mechanical type—not less than 8 ft. This will place the mechanical type instrument approximately at eye level.

NOTE 2—Dimensions "D" and "E" and installation instructions are listed on record of meter installation.

FIG. 2. Piping arrangements for system using vessel liquid in outer leg and meter body piping.

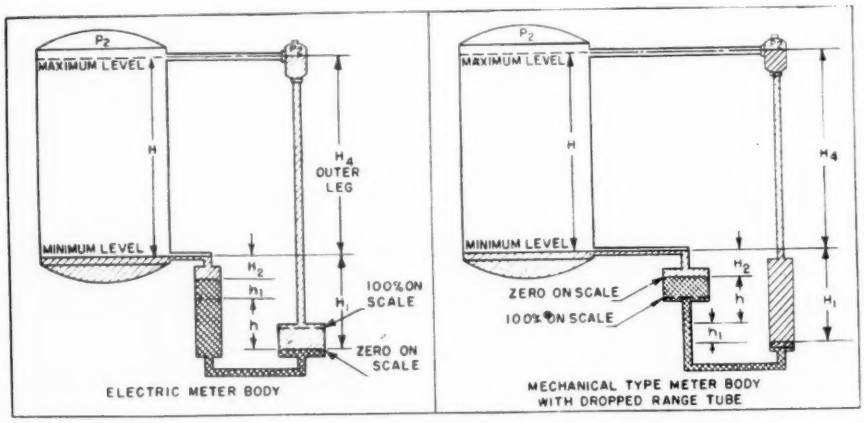
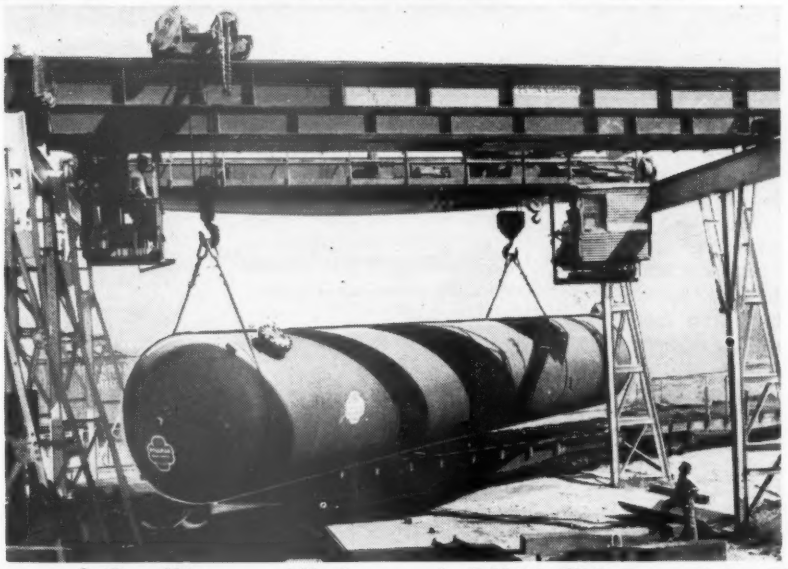


FIG. 3. Principle of operation for suppressed head system.

REFINERY VESSELS

- BUBBLE TOWERS
- PRESSURE VESSELS
- SCRUBBERS
- DRUMS
- STORAGE
- ABSORBERS



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vessel liquid is at the maximum tap level, or, in other words, the scale travel is somewhat reduced. If this characteristic is undesirable, there are two methods by which it can be overcome, namely: (1) Use of a "suppressed mercury head," and (2) use of a special sensitivity slider (instrument suppression).

● **Suppressed mercury head.** Fig. 3 illustrates the principle of the suppressed head system, wherein an additional mercury head (h_1) is added in the meter body to balance the difference in heads due to H_4 and H when the vessel liquid is at a higher temperature. This added head performs the same function in both the electric and mechanical meter bodies, that is, it permits design of the range tube on the basis of the vessel head H, but there is a difference in the manner in which the two types are placed in operation because of the dropped range tube employed with the mechanical meter.

With either type meter, the range tube is designed for differential h, which at minimum level conditions has the following formula, derived as before:

$$h = \frac{H G_1}{13.54 - G_2} \quad \ldots\ldots \quad (3)$$

Where:

h = differential in inches of mercury,
H = distance between vessel taps, in inches,
G_1 = sp gr of liquid at temperature in vessel,
G_2 = sp gr of liquid at 80 F (or other specific temperature in outer leg, etc.).

Likewise, the suppressed mercury head h_1 required, is obtained from the following formula:

$$h_1 = \frac{H_4 G_2 - H G_1}{13.54 - G_2} \text{ or } \frac{H(G_2 - G_1)}{13.54 - G_2} \quad \ldots\ldots \quad (4)$$

In the case of the Brown electric meter body, the suppressed head (h_1) is placed in the range tube above the normal head h (see Fig. 3). The meter body is first filled with mercury in the usual manner, thereby causing the instrument to read full scale. When the heads of liquid H_1, H_2, and H_4 (see Fig 3) are impressed on the meter body, the meter will read below zero. The extra mercury for the suppressed head is then placed in the meter body and the instrument reads zero.

With the Brown mechanical meter body, the suppressed head h_1 is carried in the extension tube from the float chamber to the "U-tube" (see Fig. 3). As a result, it does not involve the addition of mercury but rather must be considered in the design of the range tube length. The exact amount of mercury required, including the suppressed head, is always specified on the "Record for Meter Installation" ("RMI") sheet, which is shipped with the instrument.

To place the mechanical meter in operation, therefore, the specified amount of mercury is merely placed in the meter body. This will show no deflection of the pen or pointer, which will still remain beyond full scale. When the liquid heads H_1, H_2, and H_4 are impressed on the meter body, however, the instrument will read zero level.

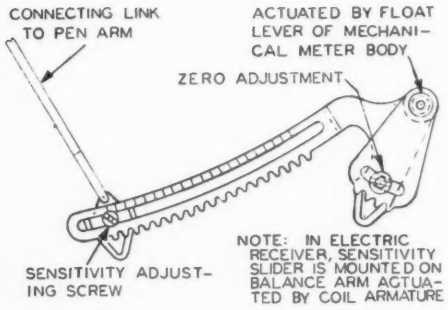

CONNECTING LINK TO PEN ARM
ACTUATED BY FLOAT LEVER OF MECHANICAL METER BODY
ZERO ADJUSTMENT
SENSITIVITY ADJUSTING SCREW
NOTE: IN ELECTRIC RECEIVER, SENSITIVITY SLIDER IS MOUNTED ON BALANCE ARM ACTUATED BY COIL ARMATURE

FIG. 4. Sensitivity slider for instrument suppression.

● **Instrument suppression.** Instrument suppression is obtained by means of a long sensitivity slider (see Fig. 4) inside the instrument case, so that the difference in density between the vessel liquid and outer leg liquid is cancelled mechanically by a change in the amount of pen or pointer movement for a given movement of the float. In this case, the range tube is designed for the head in the outer leg, as in the "Sample Range Selection" given above. The adjustment permits calibration for a standard chart or scale travel, with readings from zero to full scale for the corresponding level in the vessel, by providing a reduced float travel.

In the case of the problem considered under "Sample Range Selection" above, for example, a 0-10 ft chart or scale would be used, and the sensitivity slider adjusted so that the float travel would be reduced sufficiently to compensate for the differing densities, as follows:

With the range tube designed for the outer leg head and with the vessel liquid at the minimum level, a standard float movement of 1.2 in. would result; however, the tank head being of a lighter specific gravity will cause a return float movement of less than 1.2 in. in accordance with the relationship:

$$1.2 \text{ in.} \times \frac{10 \text{ ft}}{11.22 \text{ ft}} = 1.07 \text{ in.}$$

The sensitivity slider would be adjusted to provide a full scale reading for a float movement of only 1.07 in. instead of 1.2 in.

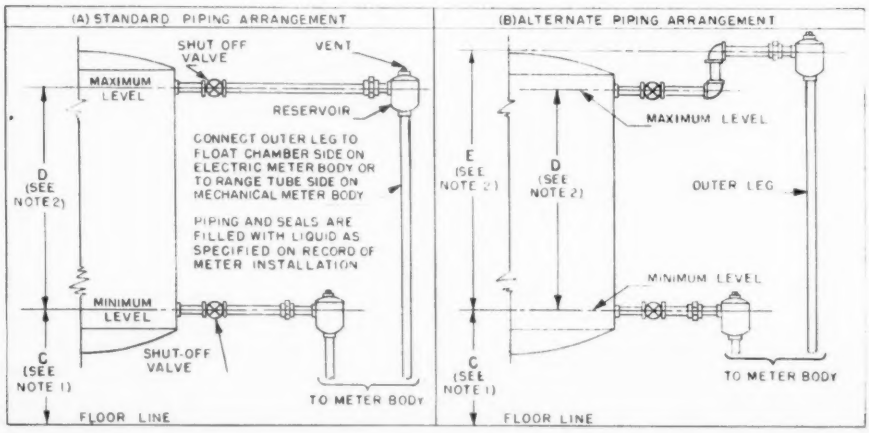
An advantage of this arrangement is that changes in operating temperatures in the vessel with resultant density changes can be easily compensated by the sensitivity adjustment, whereas in the case of the suppressed head arrangement, it is necessary to re-calibrate the meter. On the other hand, the meter installation with the sensitivity slider is not so accurate in calibration because of the magnified errors resulting from the reduced float travel. The choice as to whether or not suppression is used and, if so, which type is used depends upon the service and amount of suppression required; experienced instrument engineers should be consulted for final consideration of the application.

The use of either type of suppression has the limitation that it does not permit zeroing and checking of the meter in the customary manner employed in flow meter practice, because of the additional mercury that has been added or the instrument slider adjustment. The only way to check and zero the instrument is to have the liquid in the vessel up to the height of the upper tap, either by actual filling of the vessel or by the addition of an external leg on the minimum tap connection that can be filled with a liquid column equivalent to the tank head.

FIG. 5. Piping arrangements for system using sealing liquid in outer leg, connecting lines, and meter body piping.

NOTE 1—Vertical distance "C" for installing meter bodies equipped with standard 3-valve manifolds, should be:
(1) Electric type—not less than 5 ft.
(2) Mechanical type—not less than 8 ft.
This will place the mechanical type instrument approximately at eye level.

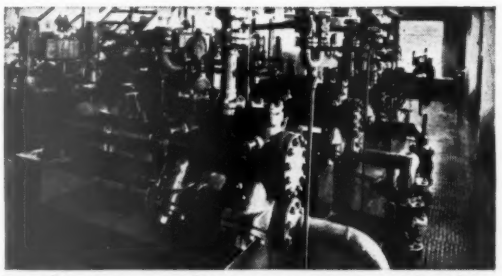
NOTE 2—Dimensions "D" and "E" and installation instructions are listed on record of meter installation.


(A) STANDARD PIPING ARRANGEMENT
SHUT OFF VALVE
VENT
MAXIMUM LEVEL
RESERVOIR
CONNECT OUTER LEG TO FLOAT CHAMBER SIDE ON ELECTRIC METER BODY OR TO RANGE TUBE SIDE ON MECHANICAL METER BODY
PIPING AND SEALS ARE FILLED WITH LIQUID AS SPECIFIED ON RECORD OF METER INSTALLATION
D (SEE NOTE 2)
MINIMUM LEVEL
SHUT-OFF VALVE
C (SEE NOTE 1)
TO METER BODY
FLOOR LINE
(B) ALTERNATE PIPING ARRANGEMENT
MAXIMUM LEVEL
E (SEE NOTE 2)
D (SEE NOTE 2)
OUTER LEG
MINIMUM LEVEL
C (SEE NOTE 1)
TO METER BODY
FLOOR LINE

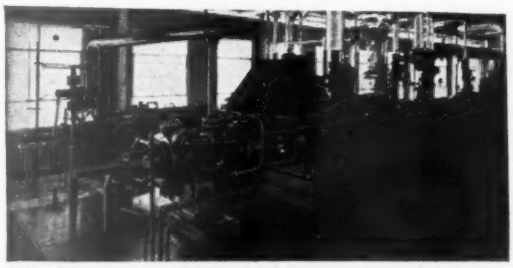
It Takes a Lot of Worthington Equipment to "Dry Out" Gas

These pictures show some of the Worthington equipment installed in The Chicago Corporation's Feazel & Kinsey gasoline plant located at Carthage, Texas, designed and built by Stearns-Roger Manufacturing Co. of Denver.

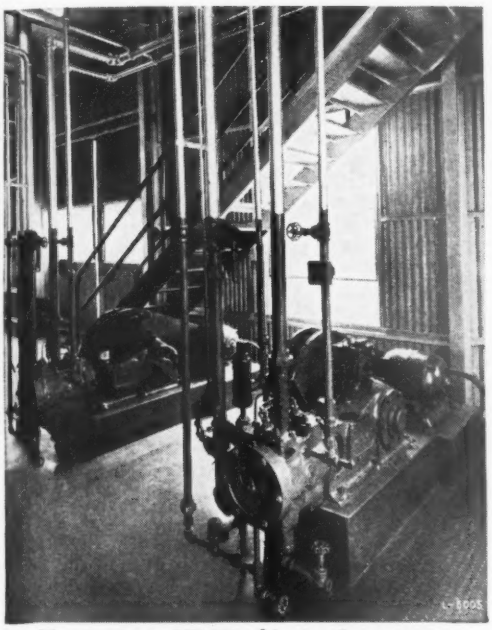
The purpose of this plant is to take the wet high-pressure gas produced from the high-pressure gas wells in the Panola County fields, and separate the water vapor from the recoverable hydrocarbon vapors consisting primarily of propane, butane, and gasoline. The residue dry gas leaving the absorbers is delivered to the pipe line for transmission and distribution.



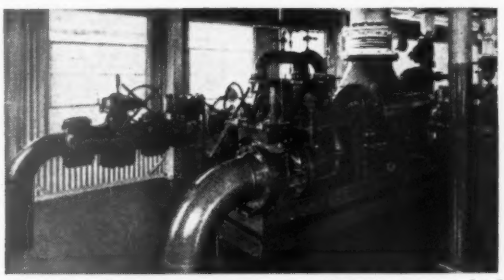
Worthington steam-driven process pumps, with turbine-driven centrifugal high-pressure lean oil pumps in background



Worthington type OXP single-stage steam-driven gas compressor used as vapor recompressor



Two 5 x 5 type HB Worthington Compressors supplying air to instruments



Two Worthington six-stage centrifugal pumps which supply absorption oil to the high-pressure absorbers at a discharge pressure of 1300 psi maximum. Each pump is driven by a 875 hp Worthington Multi-stage condensing steam turbine

Keeps Pressure on Oil Sands— Saves By-Passing Not-Needed Water

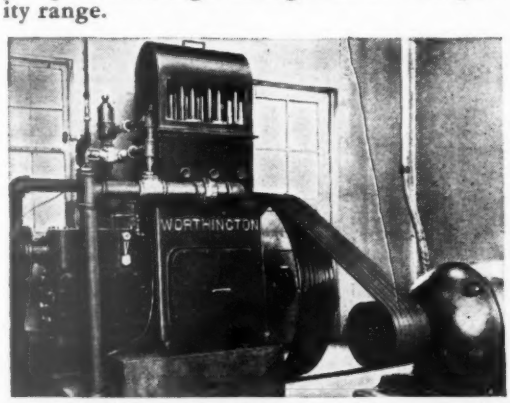
As you know, it is highly detrimental to permit variable pressure on oil sands. Any material reduction in pressure results in loss of oil production which may never be recovered.

On the Lawton Oil Company lease near Bradford, Pa., a Worthington Automatic Variflo (variable capacity) Power Pump is used for repressuring oil sands by water, and was selected for the purpose because it automatically compensates for withdrawals for other uses.

Water is taken from the discharge line between pump and input water well for house use, drilling operations, etc. The Variflo pump with its pressure governor automatically compensates for these variable withdrawals and maintains constant pressure on the oil sands.

The pump operates at 240 rpm with 500 psi discharge pressure.

The Variflo pump eliminates the necessity of by-passing high pressure water not required as the capacity pumped is automatically adjusted to the requirements of the system. By-passing liquid is inherently inefficient and the horsepower that would be wasted through by-passing is saved by using the Variflo pump, and in addition the efficiency of the Variflo pump remains high throughout its full capacity range.



2 x 4 Worthington Variflo Pump used in repressuring oil sands by water

NEWS

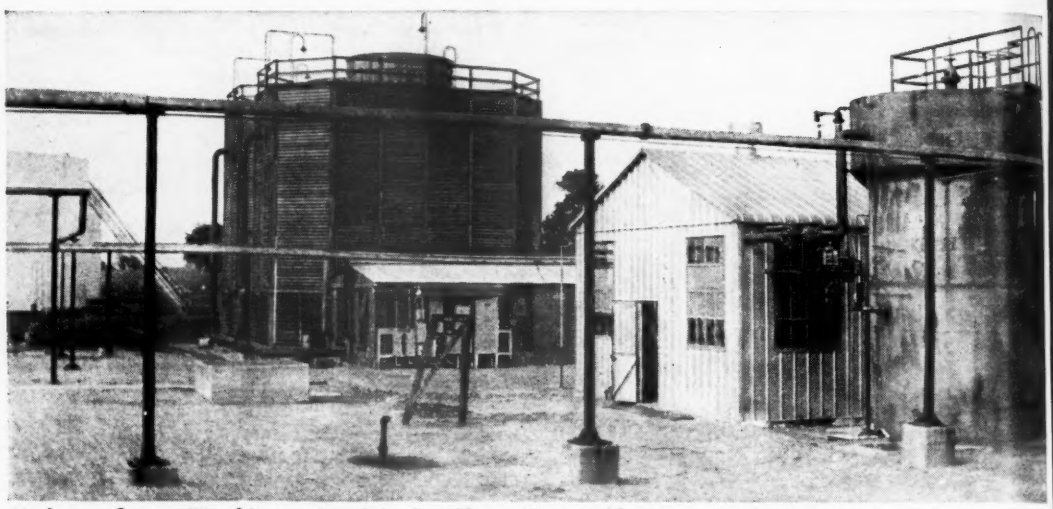
FROM THE PETROLEUM FRONT

AS REPORTED BY THE DEVELOPMENT ENGINEERS, FIELD SERVICE REPRESENTATIVES AND CUSTOMERS OF WORTHINGTON

NEWS

from the petroleum front

Worthington Water Softener Eliminates Scale and Corrosion



Modern refinery—Worthington Precipitating Slurry Type Cold Process Water Softener in right foreground; cooling towers in background

Scale and corrosion are prevented in the cooling water system of modern refineries by Worthington's exclusively-designed Precipitating Slurry Type Cold Process Water Softener. Continuous delivery of uniformly soft, stabilized, clear water is assured.

In this Worthington Water Softener, maintenance of the softener slurry bed is entirely accomplished by the scientific use of hydraulic energy provided by the pressure of the general raw water supply system.

This eliminates moving agitating parts formerly thought necessary for mixing the applied chemicals with pre-formed precipitate.

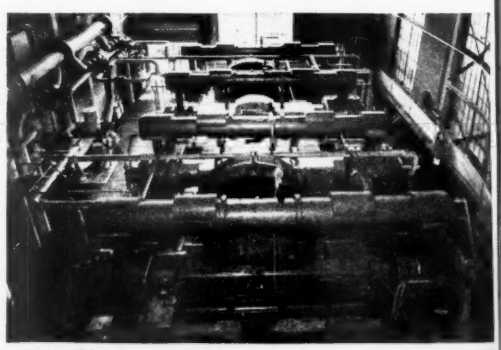
New Gas Compressors for Philadelphia Electric Co.

Demands for gas heat, for both industrial and residential use, have skyrocketed during recent years in Philadelphia. With the war's end, plans for enlargement of Philadelphia Electric Company's Chester gas plant were put into effect.

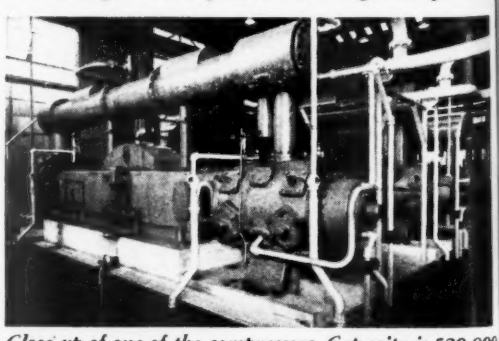
The excellent performance records of Worthington equipment—such as the 1400 hp horizontal twin-tandem two-stage gas engine compressors — suggested consultation with Worthington engineers, which led to the selection of more Worthington equipment to handle the requirements of the increased service load.

A 1750 hp motor-driven gas compressor was installed and has been in operation two years. A duplicate unit, for additional requirements, has been installed this year. Driven by synchronous motor, it is capable of delivering 520,000 cu ft of free gas per hour against a discharge pressure of 100 psi into the distributing system of gas mains.

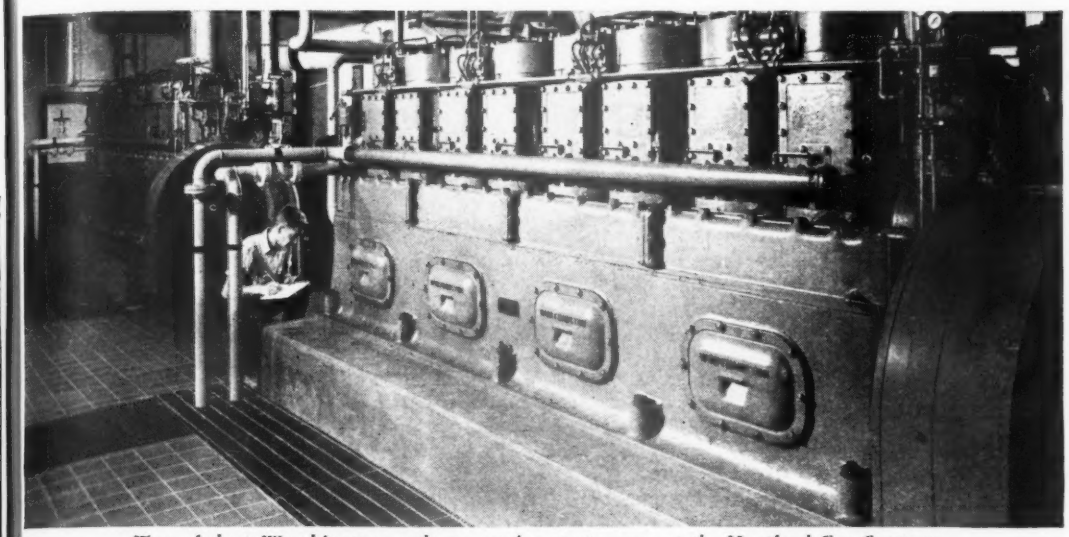
Since the gas supply to this unit is being furnished from large steel gas holders, it was necessary that special precautions be taken, in the construction of this compressor, to minimize gas pulsations in the suction gas holder. As the result of special design of the gas cylinders, pulsation has been virtually eliminated even when operating at partial capacity.



2 Worthington 1750 hp motor driven gas compressors



Close-up of one of the compressors. Capacity is 520,000 cu ft of free gas per hour against a discharge pressure of 100 psi



Two of the 3 Worthington angle gas engine compressors at the Hartford Gas Company

One of New England's Finest Compressor Installations

The Hartford Gas Company, which celebrates its 100th Anniversary this year, supplies modern gas service to 63,000 customers in metropolitan Hartford and Manchester.

The Company purchases about two-thirds of its send out gas from coke ovens at New Haven and manufactures the rest as water gas in Hartford.

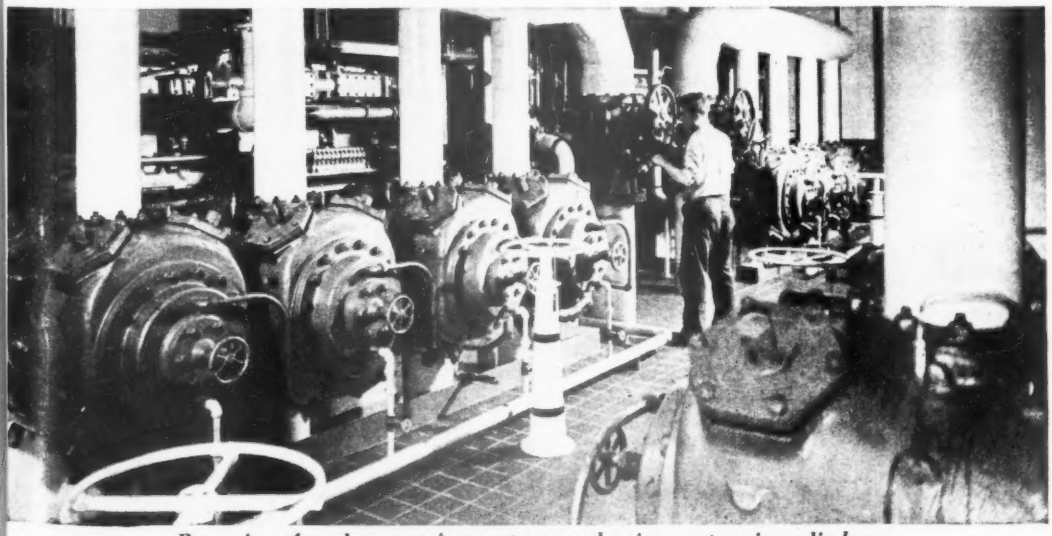
With a constant increase in gas sales, more and more of the send out has to be pumped through an intermediate pressure system.

To do the job, three Worthington LFC-8 angle engine compressors, each with eight power cylinders and four compression cylinders and each displacing 4653 cfm of a mixture of coke oven and water gas (equivalent to 225,600 cfh free gas capacity), are used.

This equipment is designed for operation normally at 25 lb gauge and, by a system of clearance pockets, to 50 lb for handling pipe line to Manchester, Connecticut in an emergency.

The photographs show why this installation has become a center of attraction for persons interested in gas distribution.

Interestingly, the coke oven gas brought from New Haven, some 35 miles away, is pumped by three other large Worthington compressors which have been in continuous service for 20 years.



Rear view of angle gas engine compressors showing compression cylinders

Worthington Pump and Machinery Corporation

•

Harrison, N. J.

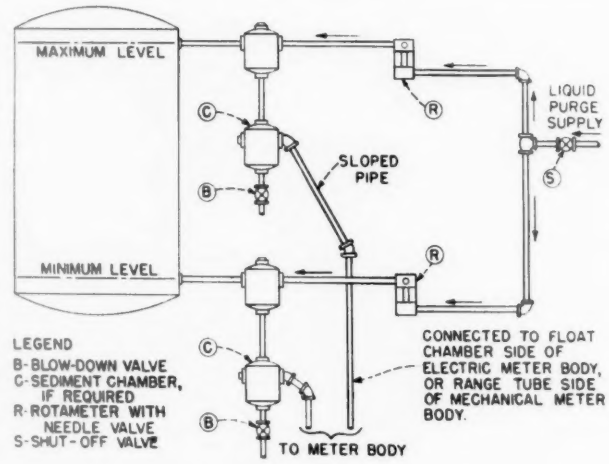


FIG. 6. Liquid purge system.

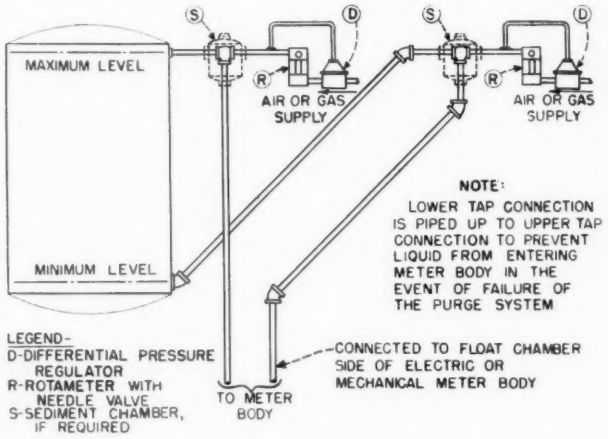

MAXIMUM LEVEL
MINIMUM LEVEL
AIR OR GAS SUPPLY
AIR OR GAS SUPPLY
NOTE:
LOWER TAP CONNECTION IS PIPED UP TO UPPER TAP CONNECTION TO PREVENT LIQUID FROM ENTERING METER BODY IN THE EVENT OF FAILURE OF THE PURGE SYSTEM
LEGEND-
D-DIFFERENTIAL PRESSURE REGULATOR
R-ROTAMETER WITH NEEDLE VALVE
S-SEDIMENT CHAMBER, IF REQUIRED
TO METER BODY
CONNECTED TO FLOAT CHAMBER SIDE OF ELECTRIC OR MECHANICAL METER BODY

FIG. 7. Air or gas purge system.

● **Sealing liquid.** Level measurements of liquids that are free of excessive solids but must be sealed from the meter body are often handled by the piping arrangement shown in Fig. 5, wherein seal pots are situated at the minimum and maximum connections with the meter body connecting lines filled with a sealing liquid. This system is almost universally used in oil refinery service where the measurement of liquid levels in pressure vessels is required. In this service, the sealing liquid is generally heavier than the vessel liquid, quite often being a 50-50 mixture of glycerine and water, which has a gravity of 1.125 at 60 F. The system is also applied frequently for measuring the level of light volatile liquids, such as butane.

With the sealing liquid of a heavier gravity than the vessel liquid, the same three methods of applying differential-pressure meters are available, as previously described for the first system wherein the outer leg contains vessel liquid at a lower temperature (heavier gravity), namely:

(1) The use of a chart or scale range that is greater than the vertical tap distance.

(2) The use of a suppressed mercury head.

(3) The use of instrument suppression.

The first method is rarely, if ever, acceptable in services such as found in an oil refinery where rising of the vessel liquid above the maximum level can result in spoilage of the product. Choice between the second and third methods depends upon the conditions previously discussed. Where a number of meters are involved, the additional mercury required for the mercury suppression method may become a pertinent consideration.

In the first method, the formula for the range tube differential is:

$$h = \frac{H G_s}{13.54 - G_s} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

and the range of the meter will be $H \times G_s/G_1$.

Where:

H = distance between taps in inches,

G_1 = vessel specific gravity at operating temperature,

G_s = sealing liquid specific gravity at its operating temperature (about 80 F).

In the second method, the range tube differential is:

$$h = \frac{H G_1}{13.54 - G_s} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and the suppressed head is:

$$h_1 = \frac{H(G_s - G_1)}{13.54 - G_s} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

In the third method, the differential of the range tube is given by the same formula (5) as for the first method, and the actual float travel will be 1.2 in. times the ratic G_1/G_s.

● **Interface level.** In certain industries, particularly in oil or chemical plants, it is often necessary to measure the interface level between two immiscible liquids in a closed vessel. The general operating principles of the electric or mechanical type meters for such service are much the same as the previously described system involving a sealing liquid in the outer leg and meter body piping, except that a second lighter liquid fills the space above the measured interface level at least up to the upper meter tap.

As an example of the range tube calculation for such a system, consider the simplest case wherein the lower (heavier) liquid can be impressed on the meter body and is used as a seal on the outer leg. With reference to Fig. 1 (assuming the space above the minimum level to be filled with the lighter liquid) the equation for balanced liquid columns at minimum interface level becomes:

$$HG_1 + H_2G_2 + h.13.54 = (H_4 + H_1)G_2.$$

Substituting for H_1 and H as previously described and solving for h, the following formula is obtained:

$$h = \frac{H(G_2 - G_1)}{13.54 - G_2} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Where:

h = range tube differential in inches of mercury,

H = distance between interface level taps, inches,

G_2 = specific gravity of heavier liquid,

G_1 = specific gravity of lighter liquid.

It will be noted that the balanced column equation contains an added head HG_1 on the left-hand side, because the lighter fluid fills the vessel above the lower tap. The required differential is thus decreased by this amount. Otherwise, the case is exactly the same as the previously considered system and the effects of differing gravity in the outer leg or mercury suppression are similarly handled.

● **Liquid purge system.** The purge system employs a suitable liquid constantly flowing from a source of supply through the level tap connections as shown in Fig. 6, and into the vessel. The meter body, connecting piping, and outer leg are filled with the purge liquid. Needle regulating valves with "C-Clamp" rotameters in the two lines to the legs are adjusted so that the flow of liquid into the vessel is at as low a rate as possible, yet sufficient to prevent the vessel liquid from entering the connecting lines. The flow through each line must be the same.

Applications of this system are for corrosive liquids, for those having entrained solid particles, and for liquids that when cooled in the meter body and piping would solidify or precipitate solids. Because of the numerous and different liquids that may be handled, it is usually better that such applications be referred to Brown factory engineers. One

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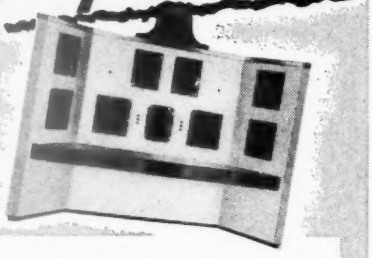

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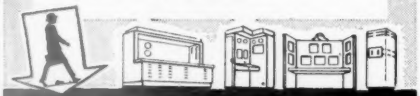

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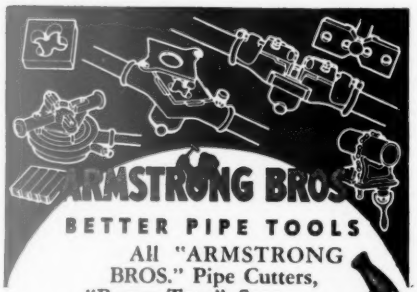

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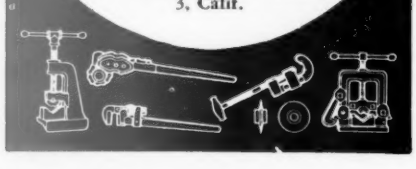

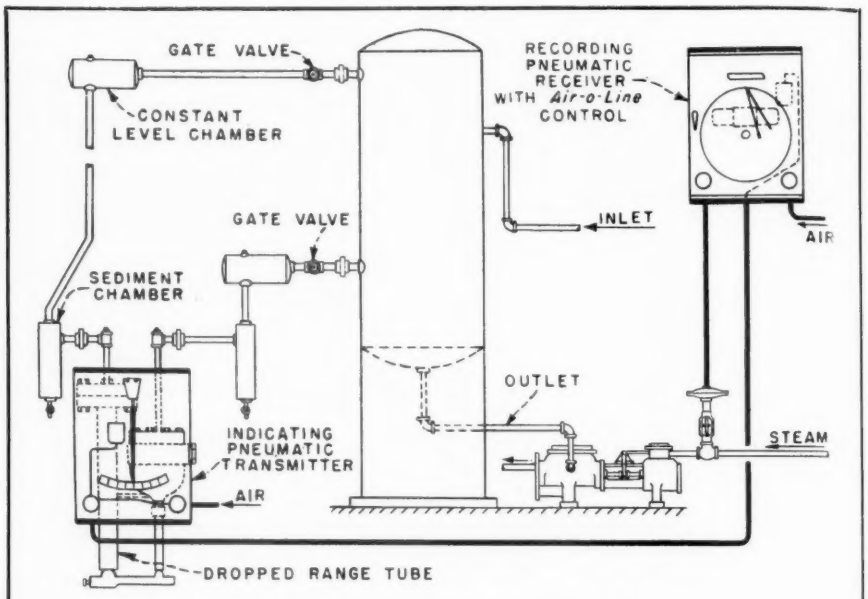

FIG. 8. Typical liquid level installation utilizing pneumatic transmission.

limitation of its use is the operating pressure in the vessel, for high pressure in the vessel would necessitate high purge pressures that might be excessive.

The general principle of operation of this system is the same as that of the system just described, wherein a sealing liquid is used in the outer leg and meter body piping. A purge must be maintained through both legs, even though the vessel liquid may never reach the maximum level connection, because for correct level readings, both sides of the meter body must be subjected to the same purge flow. The flow of liquid into the lines is at a low rate so that there is no appreciable velocity head and any minor effect is impressed equally on both sides of the meter body.

● **Gas or air purge.** The gas or air purge system, illustrated in Fig. 7, is fundamentally the same as the liquid purge system, the scavenging medium being air or gas instead of liquid. Likewise, the system can, in general, be used on the same applications as outlined for the liquid purge system. The pressure in the vessel must, of course, be less than the available gas or air pressure. Differential pressure regulators are recommended installed across the rotameter with needle valve to assure constant flow of the purge medium.

In operation, the flow of gas or air is regulated so that there is no appreciable velocity head. The meter body, connecting piping, and the outer leg are filled with the gas, and, as the gas density can be neglected, the only head effect to consider in the range tube selection is that due to the liquid in the vessel. In this system, therefore, the minimum level connection is made to the float chamber side of the meter body, whether it is of the electric or mechanical type and, in the case of the latter, the dropped range tube construction is not required.

Thus, the range tube differential is calculated on the following basis:

$$h = \frac{H \times G_1}{13.54} \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

Where:

H = maximum measured head in the vessel, inches,

G_1 = specific gravity of the vessel liquid at its operating temperature.

● **Remote transmission.** Frequently, it is desired to measure the level in a closed vessel at some location in the plant and have the recorder or recording controller at a remote centralized control panel. The electric meter body inherently permits remote transmission of the level measurement, for it utilizes an induction bridge circuit with the meter body connected to the indicator or recorder by a three-wire cable. Where desired, an indicator, situated near the vessel, can be connected electrically in parallel with a remote recorder or recording controller —thus providing the operator with an indication of the level at the process as well as a permanent chart record in the control house.

When the mechanical level meter is used, the meter body can be supplied mounted on the back of an indicating pneumatic transmitter placed near the process vessel. The Brown pneumatic transmission system, utilizing matched transmitting and receiving bellows, assures accurate and responsive recording of the level in a remote recording receiver. A typical arrangement of such a system is illustrated (Fig. 8) wherein the receiver is equipped with Air-o-Line control for regulating the outlet flow. If desired, the transmitter can be provided with pneumatic control, instead; and, if remote adjustment of its set point is desired, a Remoteset panel can be installed on the recorder panel to position the set point pneumatically. ★ ★ ★

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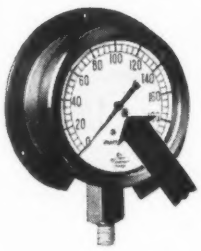

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"THE STANDARD OF ACCURACY"

General view of pressure maintenance and crude stabilizing plant in the Olive field, Texas, of Pan American Production Company. This is possibly the smallest field from standpoint of reserves in which a pressure maintenance plant has been installed.

Small field gets pressure maintenance

By FRANK H. LOVE, *Managing Editor*

PAN AMERICAN PRODUCTION COMPANY has installed a pressure maintenance and crude stabilizing plant in the Olive field, Texas, possibly the smallest field from a standpoint of reserves in which pressure maintenance has been tried. This field, which is in Hardin County about 26 miles north of Beaumont, has three producing wells and one injection well. The wells are producing from a depth of approximately 10,000 ft with an exceptionally high gas-oil ratio of 5000 cu ft of gas to 1 bbl of oil. The wells are unusual, also, in that the bottom-hole pressure is 6300 psi compared with an approximate normal pressure at that depth of 4700 psi. Gravity of the oil is 54-deg API.

EXCLUSIVE

Prior to the installation of the pressure maintenance and crude stabilization plant the gas produced with oil was wasted. Now the entire gas production is either returned to the producing reservoir or used as plant fuel, thus creating a gas reserve for future use while also substantially increasing the ultimate recovery of crude oil. All this, of course, is in the interest of gas conservation, a program in which Pan American has always been cooperative.

Residue gas is being returned to the producing formation through one injection well as a pressure of 4800 psi, and the crude oil after being stabilized is sent to atmospheric storage from which it is moved to destination by pipe line.

● **Plant flow.** A description of the flow through the plant follows:

Production from the wells first passes through adjustable chokes, a reducing regulator, and preheater to enter a 1000-psi separator. Here a part of the water is removed and the crude oil and gas separated. The fluid is flashed down to a pressure of 400 psi

Make Wire lines Behave

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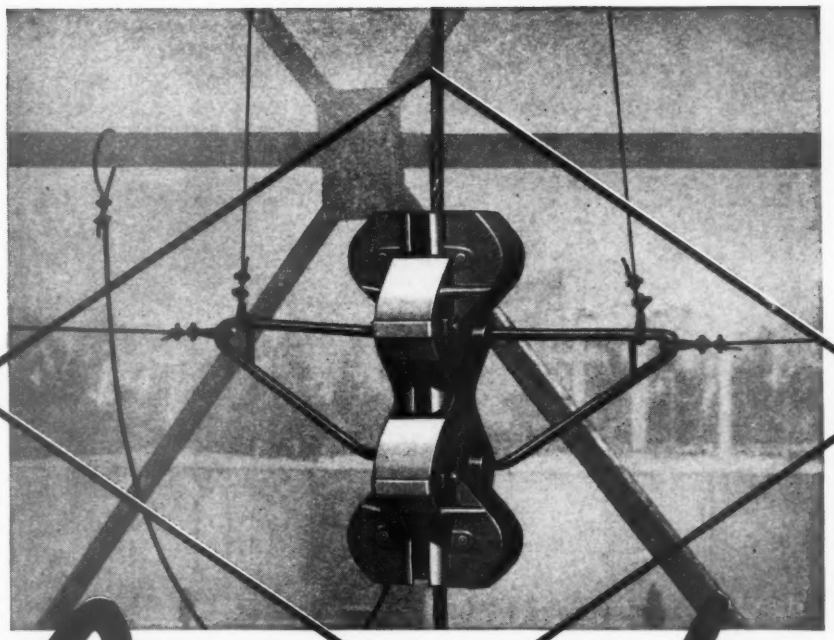

Roliguide

PROTECT YOUR RIG FROM WIRE LINE WOBBLE

Wire line whip causes uneven spooling and piling up of the line on the drum. Kill this whip and reduce chances for wire line trouble with the NEW Patterson-Ballagh ROLIGUIDE. This roller type Wire Line Guide operates in freezing weather and easily handles both dry and lubricated lines.

Vibration and whip do not have a chance when you install the new Patterson-Ballagh ROLIGUIDE on your rig. The greater over-all length of the Guide and the large number of rollers give the stability that efficiently kills vibration. Each of the eight rollers rotates on two races of grease packed, over-capacity ball bearings. They absorb the vibration and transmit a larger portion of it to the body of the Guide and the hanging assembly. Each long-wearing roller is completely housed in the body so that it *can not* drop out or throw oil on the crew or rig.

EACH ROLLER, code: ROLIFILL, is covered with tough, long-wearing rubber. Easily replaced in Wire Line Guide. Additional rollers furnished on order.

For more information on the ROLIGUIDE, write for free bulletin or call your Patterson-Ballagh man today!

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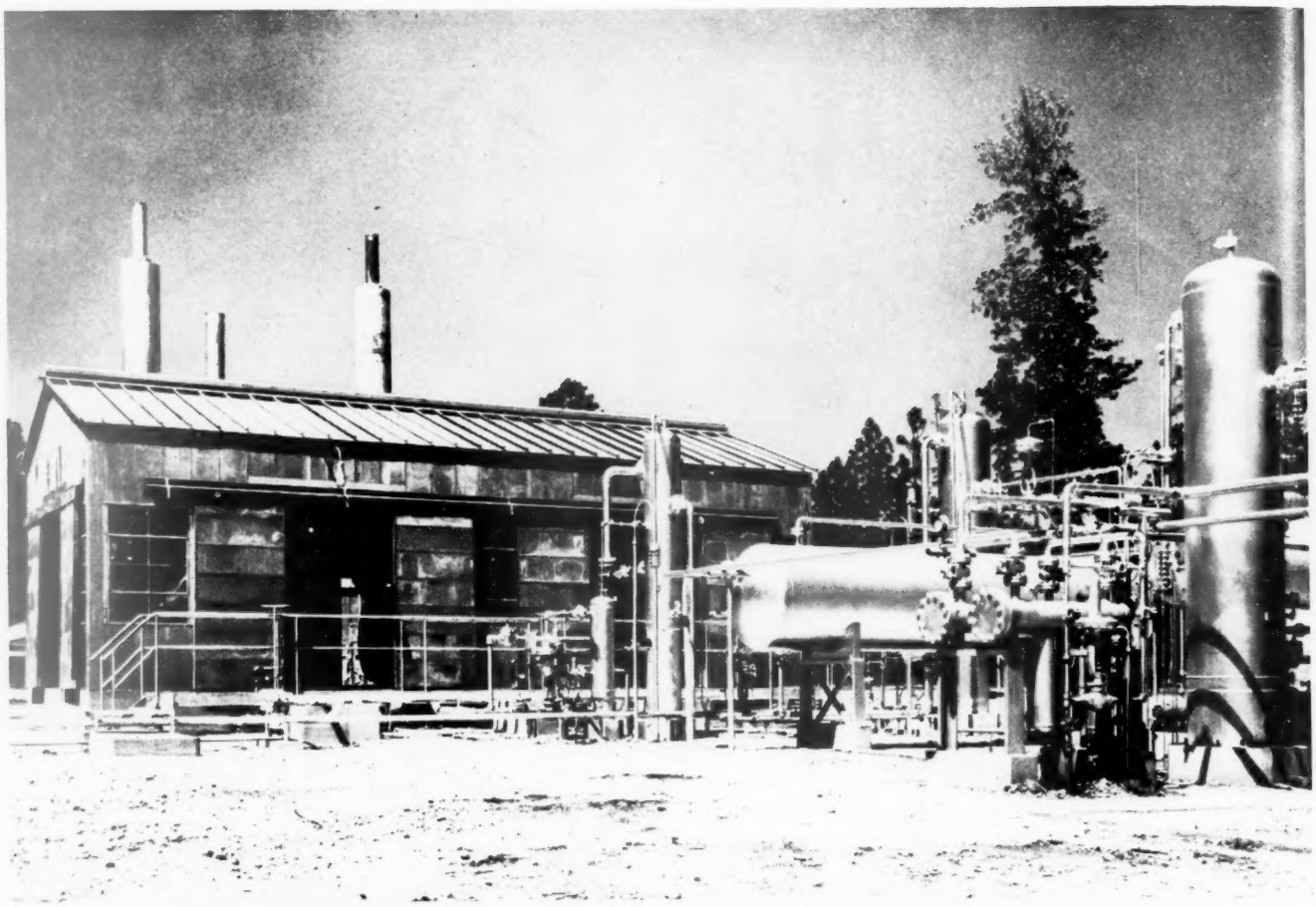
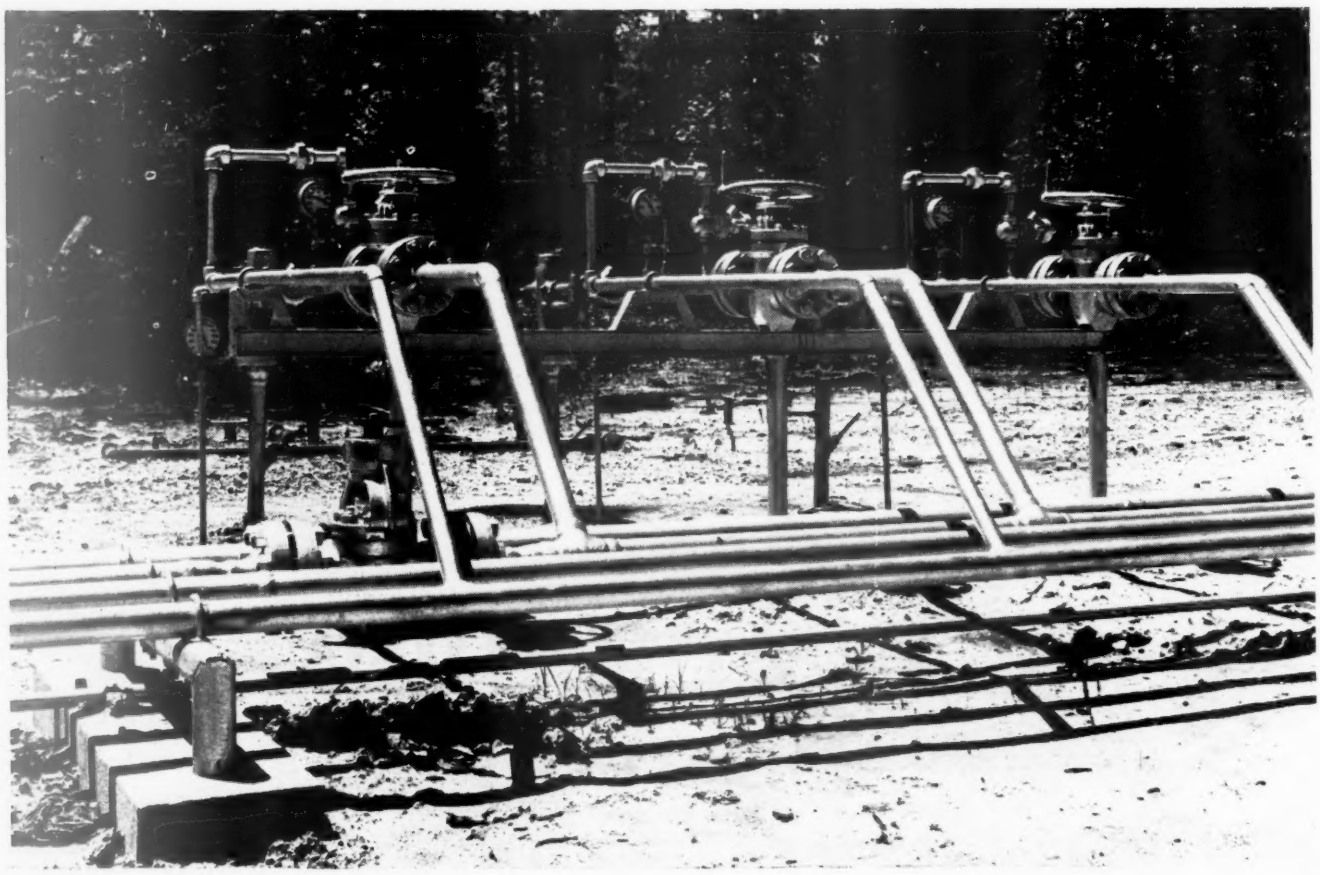
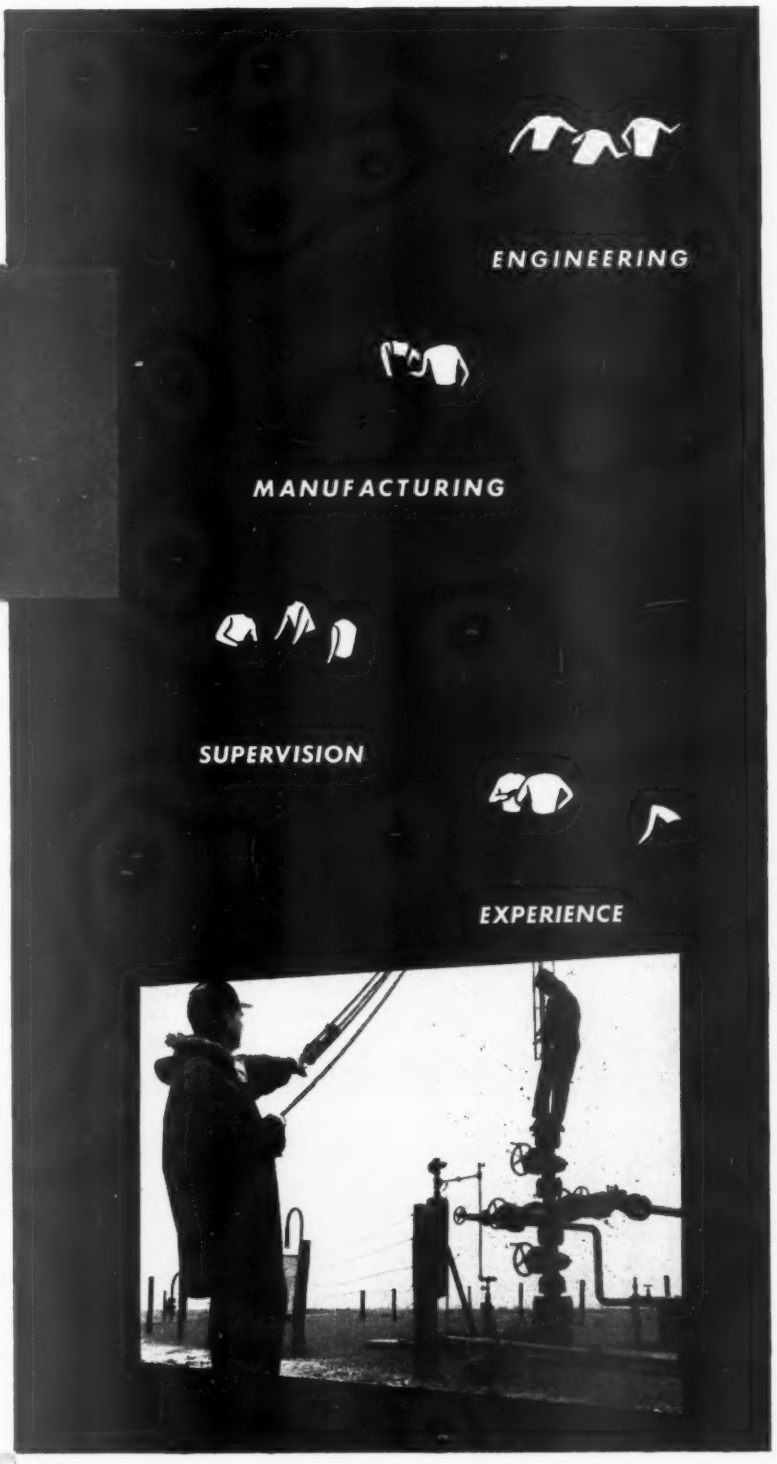


Residue gas is being returned to the producing formation through a single injection well. The compressor building is shown in the left background of the photograph above. At right is a part of the stabilizing equipment. Below is the inlet manifold. Bottom hole pressure is exceptionally high, 6300 psi. Pressure is reduced to 1000 psi to enter the plant separator.



2*

SERVICE, four deep!



When Otis Pressure Control, Inc., accepts the job of performing wire line service work on flowing wells, that service neither begins nor ends solely with field personnel and equipment available at the well site. Whether it's a routine or emergency operation you can call Otis with confidence. You'll get service, four deep! Experience. Supervision. Engineering. Manufacturing.

Each service unit is headed by a wire line specialist, highly-trained through years of field *experience* in high-pressure production problems and practices. This man directs operations with mature consideration for safety to personnel and well facilities; the efficient use of wire line tools; and the economic success of the job to the customer.

If he is faced with a complex operation requiring executive *supervision* that assistance is available immediately.

If standard tools and equipment are not adequate under certain unpredictable conditions Otis *engineering* personnel steps into the picture. Their designs for new or modified tools are then executed by one of the finest specialized *manufacturing* plants in the petroleum industry.

Otis Wire Line Services, performed under pressure, include: running and pulling Otis Sub-Surface Controls; surveying tubing for corrosion; perforating or cutting tubing; cleaning paraffin; fishing jobs; drilling gate valves; repairing or replacing wire line stuffing boxes; plugging tubing and drill pipe.

***NO. 2** *in a series of high-pressure production problems and practices and the allied use of Otis Sub-Surface Controls and Services. Reprints of the series, suitable for filing, are available upon written request to Otis Pressure Control, Inc., Box 7206, Dept. A., Dallas, Texas.*

NEW LITERATURE AVAILABLE

"Otis High-Pressure Wire Line Stuffing Box." Bulletin No. 48-103 gives a comprehensive description of the new Otis Wire Line Stuffing Box (10,000 p.s.i. test). Included are data, parts list, and operating instructions. Write to address shown above.

PRESSURE CONTROL — OTIS — SERVICE — EQUIPMENT

OTIS PRESSURE CONTROL, INC.

(T-19)

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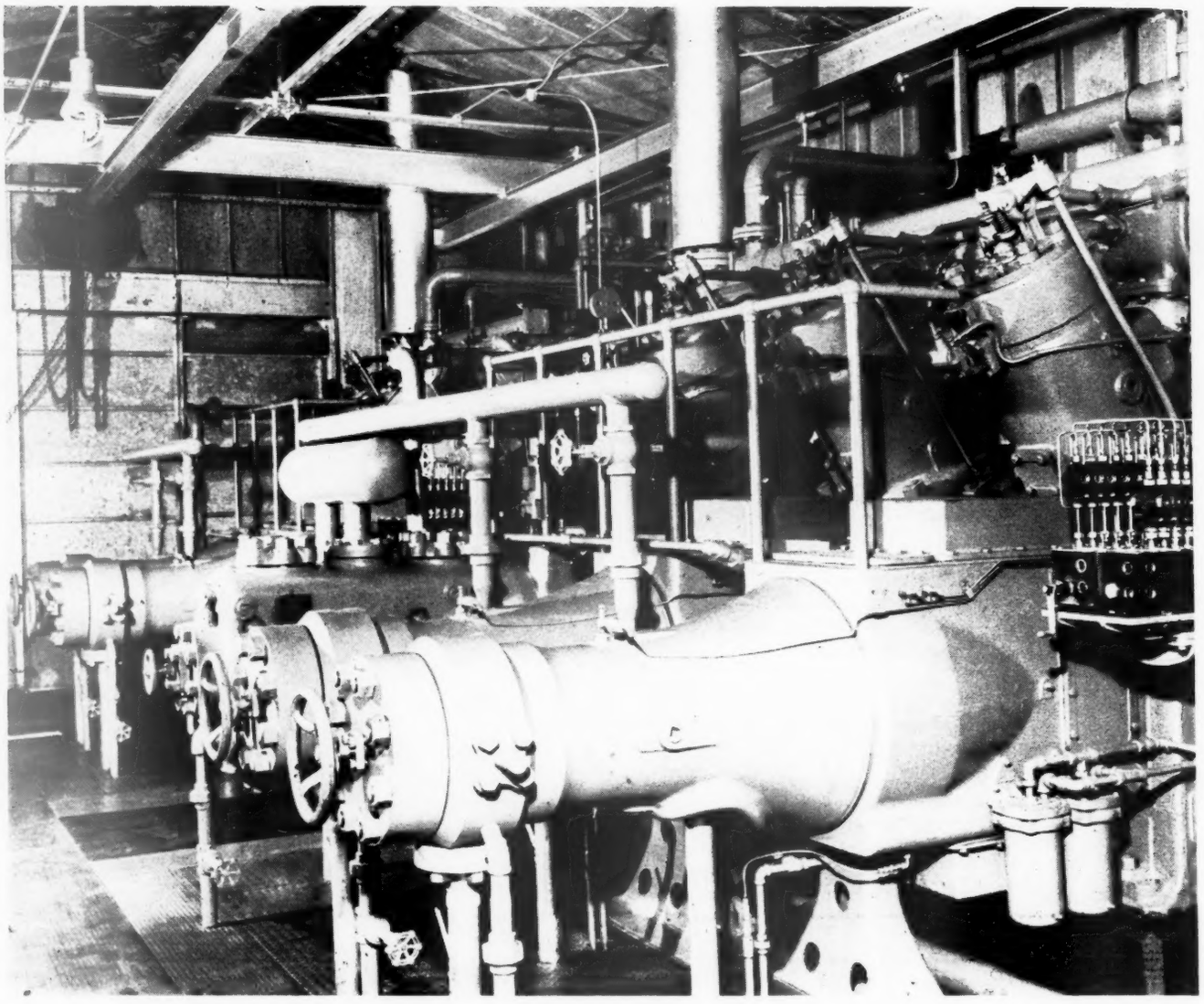

Two compressor units compress the gas to a pressure of 4800 psi for injection into the producing formation. One unit has 300 hp, the other 200 hp. The two units have a combined capacity of 4,166,000 cu ft of gas a day, but at the present time only the 300-hp unit is used inasmuch as the field's allowable is only 500 bbl a day and injected gas volume 2,2500,000 cu ft a day.

and discharged into a horizontal settler where the remaining water is removed. The fluid is then picked up by an electric-motor-driven pump and discharged through line filters packed with glass wool, and a regulator controlled by the fluid level in the 400-psi flash. It is then passed through a bank of heat exchangers where cold feed sub-cools the overhead product, thence to the second bank of heat exchangers where it exchanges heat with the bottom product from the stabilizer. The function of the stabilizer is to make a substantially propane-free crude oil, which in this case is a 14-lb vapor pressure, 54-gravity crude.

Overhead vapors from the stabilizer pass first through an air-cooled condenser, then to primary exchange, and on into the reflux accumulator. Both the feed and the reflux pumps are equipped with mechanical seals and are driven by electric motors. Steam for the reboiler is supplied by a 25-hp. 400-psi water tube boiler.

The bottom product from the stabilizer, after exchanging heat with the cold feed. is further cooled in an air-fin unit.

● **Gas cycle.** Two compressor units are provided to compress the gas from inlet pressure to the 4800-psi injection pressure. First stage compression handles uncondensed stabilizer vapors and excess 400-psi flash vapors, compressing the gas from 250 psi to 1000 psi. The second stage takes gas from the first stage plus the 1000-psi separator gas and compresses to 2000 psi. In the third stage the gas is compressed without intercooling to the final injection pressure of 4800 psi.

One compressor unit is 300 hp, the other 200 hp. The 300-hp unit has three compression cylinders and the 200-hp unit has two. The two units have a combined capacity of 4,166,000 cu ft a day and were installed in anticipation of this volume after gas-oil ratios increase. At the present time, only the 300-hp compressor is needed, as the field's allowable is only 500 bbl a day and the injected gas volume about 2,250,000 cu ft a day.

Jacket water pumps are mounted directly on the engines and the jacket water is cooled by three core-type air-cooled radiators.

Electricity is provided by 40-kw, 50-kva, 3-phase, 60-cycle, 480-volt, 900-rpm generators direct connected to gas engines.

As makeup water requirements for the boiler and jacket water system are limited, a small jet pump is provided for this purpose.

Fuel gas for the boiler, compressor engines, and flowline heater is taken from the 400-psi flash. Controls have been installed so that during a peak demand fuel gas also can be taken from the 1000-psi separator.

The plant was designed and constructed by O. L. Olsen, contractor, Houston, Texas. ★ ★ ★

new and improved machinery and equipment

A REGULAR FEATURE
appearing in
THE Petroleum Engineer
Irwin-Keasler Building
Dallas 1, Texas

(1) Rotojet cleaner

Greatly increased power is claimed by the Elliott Company, Roto Division, for its new Rotojet Junior cleaners for small tubes. The equipment is designed to remove scale and other deposits from tubes as small as 0.495 in. ID in boilers, condensers, evaporators, superheaters, and other tubular apparatus, quickly and economically.

By the use of newly developed materials and by redesign based upon aerodynamic and hydraulic research, Rotojet Junior tube cleaners are said to develop unusual power, considering their small size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Rotojet motors are available for operation with air or water.

(2) New trailer

The Cleveland Trencher Company has announced its improved Model T-10 equipment and material-hauling trailer. The T-10 is a flat bed, 2-axle front loading model designed for moving overhead shovels, rollers, tractors, cranes, trenchers, bulldozers, backfillers, front end loaders, machinery, pipe, steel, lumber, etc.

Some of the more important features listed by the manufacturer are:

This trailer requires no special type vehicle for the hauling. Any ordinary dump, stake, or tractor truck or rubber-tired industrial tractor will do the job quickly and easily over any terrain on which they will travel.

Extremely low loading height (under 24 in.) minimizes all bridge and overhead wire problems and enables the user to keep within all federal and a majority of state road laws.

Sturdy, quality construction, even weight distribution, generous-size tires and 4-wheel electric brakes under instant control of truck driver at his seat, assure safety and speed on the road.

Front loading and unloading on the model T-10 is accomplished, according to the manufacturer, with a maximum of speed and safety through the unique yet simple design of the trailer front. Two adjustable feet (one on each front corner) controlled by a built-in easily accessible hand-operated hydraulic jack, in front center, permit the easy removal and replacement of the front axle and tongue. These two front feet together with the rear wheels of the trailer give a four point support that minimizes the loading angle and reduces materially the hazards of tipping and slipping.

(3) Industrial engines

Unit construction employed in the design of Hall-Scott industrial engines makes for ease of servicing and insures a minimum loss of time in engine idleness, according to the manufacturer, Hall-Scott Motor Division of ACF-Brill Company, Berkeley 2, California.

Component units, such as water pump, oil pump, oil filter, cylinder head assembly, etc., are attached to the engine as complete assemblies. Each assembly is readily accessible for easy removal and replacement without the necessity of dismantling the entire engine. The unit so removed can be reconditioned at leisure, insuring a better job than if pressed for time due to engine shutdown. The engine meanwhile, fitted with a spare unit, is kept in service. This holds true for the cylinder head, which contains the valves and complete valve actuating mechanism, and for all other units.

Also offered by the same company is the Hall-Scott Model 400 engine that provides the trucking industry with a powerful, dependable, and efficient power unit. The engines are equipped to operate on either butane-propane or gasoline, and are said to develop tremendous power at low engine speeds, pulling big loads at maximum speed.

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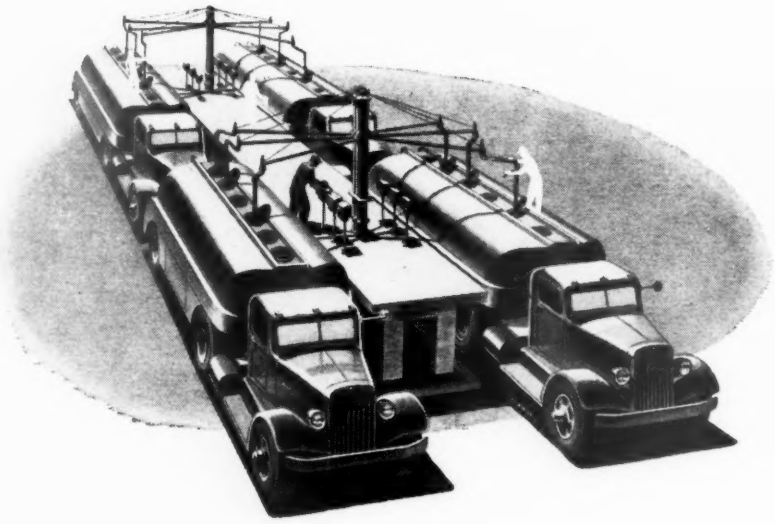

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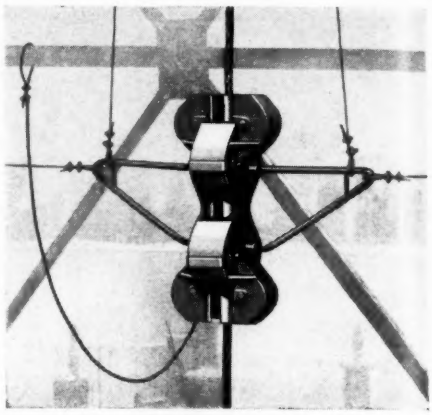
(4) Wire line guide

This new Patterson-Ballagh wire line guide, shown in the accompanying illustration, properly stabilizes wire lines due to the greater overall length and the large number of rollers. Uneven spooling and piling up on the drum is completely eliminated, it is stated. The Roliguide handles both dry and lubricated lines. Each of the eight rollers rotates



on two races of grease packed, overcapacity ball bearings. They absorb the vibration and whip of the wire line and transmit a greater portion of it to the guide body and the hanging assembly.

Rollers are covered with tough, wear-resistant rubber and are completely housed within the body so that no oil can be thrown out on the crew or rig. Replacement parts are quickly and easily installed, it is asserted.

(5) Ribbon anode

New equipment for protecting buried metal structures from corrosion by means of cathodic protection is Galvo-Line, a magnesium ribbon anode that has been developed and tested by the laboratories of The Dow Chemical Company, according to Arthur Smith, Jr., manager of anode sales for that firm.

The new anode has a cross-section of $\frac{3}{8}$ in. by $\frac{3}{4}$ in. and contains a centrally located core of iron wire to facilitate making permanent electrical connections and to prevent possible segregation.

It is designed for use primarily in high resistivity soils where cast anodes may not be practical because of their low current output under such conditions. The magnesium ribbon anode provides faster, simpler, and less expensive methods of installation, it is asserted. In addition it reduces current requirements to a minimum by offering more uniform distribution and better utilization of current from the anode.

Because Galvo-Line's elongated form presents a high area to weight ratio, the new anode supplies from three to seven times as much current per pound of magnesium installed as does the conventional cast anode, it is stated.

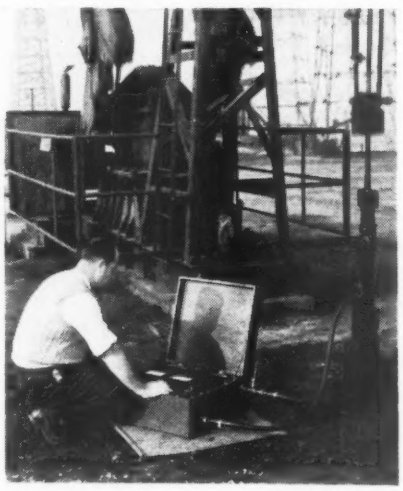
For protection of underground structures the magnesium ribbon can be installed very simply by using a wire-laying plow on which a reel of magnesium ribbon anode is mounted. The anode is installed in a furrow between 16 and 24 in. deep and is spaced some 2 to 10

ft from the structure to be protected. No chemical backfill is necessary and connections are made to such structures as pipe lines about every 500 to 1000 ft where light current flows are expected. If larger current flows are involved, connections must be made at shorter intervals, of course. Whether Galvo-Line is used alone or combined with cast magnesium anodes depends upon the resistivity and uniformity of the soil.

The ribbon anode may also be used successfully as emergency protection for metal structures until more permanent protection programs are put into use, or in very low resistance soils if the rapid polarization provided by the ribbon can justify itself in terms of reduced current demand. Otherwise, the new anode is intended for use in high resistivity soils or in conjunction with cast anodes in order to increase the efficiency and flexibility of cathodic protection installations. The ribbon anode also has many important applications where protection of underwater structures is necessary.

(6) Corrosion in wells

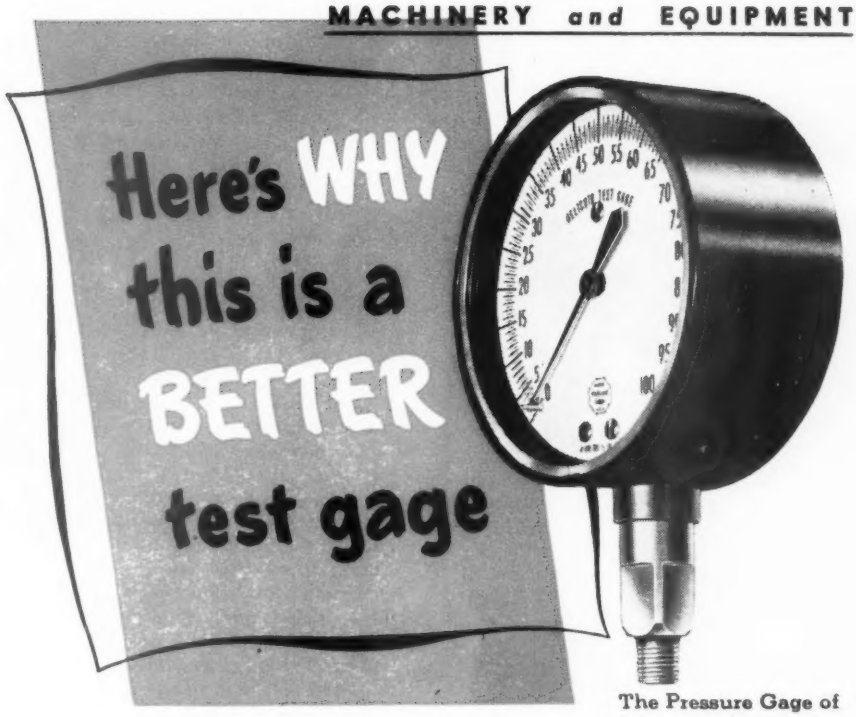
A new method for controlling electrochemical corrosion on tubing, sucker rods, and pump parts in pumping oil wells has been developed during the last two years by The Cypher System, Inc. This method uses a specially designed mixing device to make a stable emulsion of the oil and brine before it enters the pump. Oil is drawn into the mixer at its lower end and a tail pipe extends downward into the brine, permitting a variation of the oil-brine interface level. Metering orifices in the tail pipe and oil intake maintain a consistent mixture,



which, after being emulsified in the mixer, has a high electrical resistance to the flow of currents generated in the well fluid, thus the electro-chemical corrosion is eliminated or substantially reduced.

The device does not create a costly treating problem. Where demulsifying chemicals have been used at the surface a reduction of treating costs have been noted, which is probably the result of maintaining a constant mixture at the pump.

The effectiveness of the mixing device is determined at the wellhead sample cock with electronic instruments before and after the installation.



The Pressure Gage of Enduring Accuracy

● An example of rugged, durable and weatherproof construction combined with sensitivity and extreme accuracy is the new HELICOID TEST GAGE for Reid Vapor Test Bombs.

May be used for any service where an accurate, portable test gage is required.

4-1/2" dial size—white laminated Phenol durable dials.

Special, phosphor bronze Bourdon tube for greatest torque at low pressures.

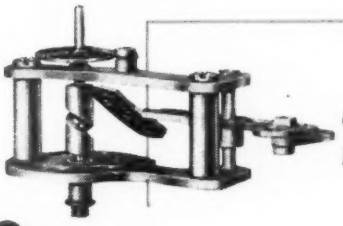
Stainless Helicoid precision movement.

External micrometer pointer adjuster.

Acaloy, flangeless, weatherproof case with rich black baked finish. Stainless steel (18-8) snap ring and Neoprene gasket.

Long, stainless steel (18-8) shank, with square and with 1/4" male pipe thread.

Accuracy guaranteed to within 1/2 of 1%.



Only Helicoid Pressure Gages have the Helicoid Movement

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TRADE MARK

(7) Chemical pump

For use where electric power is not available a new chemical pump, in simplex and duplex models, powered by a 1-hp rotary air motor, is being offered by the Milton Roy Company. This "Airometric" pump is operated by natural gas or compressed air as the prime mover, at air pressures from 50 to 80 psi. A pressure regulator and indicating gage are supplied with each unit to reduce the supply pressure to that required for pump operation. Maximum motor speed is 1750 rpm, held constant by a governor that throttles the air exhaust from the motor. Drive is through a speed reduction unit. The motor and mechanical system are balanced by means of a fly-wheel fixed to the motor coupling.

Maximum pumping capacities are (simplex) from 1.2 to 75.5 gph; (duplex) from 2.4 to 151 gph. Maximum discharge pressures range from 115 to 9500 psi, varying with the volume of liquid pumped. Pumps will operate efficiently at any discharge pressure. Liquid ends are the same positive displacement step-valve construction as used in electrically driven Milton Roy pumps and are available in iron, steel, and alloy metals to meet practically all corrosion resistant requirements. Pumps are accurate metering units affording precise control of volume of liquid pumped to as little as 1 pint per hour.

Applications include the pumping of chemicals in controlled volume and in small quantities, the handling of difficult or corrosive materials, pumping chemicals into flowing oil wells to minimize corrosion, pumping treating chemicals into boilers or boiler feed water lines, or any other purpose where a chemical pump is required and electric current is not available. Another application is in processing operations where explosion hazards prohibit the installation of electrical motors. These units are also applicable as components in chemical feed systems for automatic pH control and similar automatic proportioning purposes.

(8) Pneumatic control

A totally new pneumatic control mechanism is now incorporated into all Fischer and Porter flow controlling instruments. The housing for this new unit consists of a one-piece die casting. This results in all component parts being maintained in a positively fixed relationship to each other.

All important working parts are made from precision castings or heavy stampings, precision trimmed and carefully inspected to assure interchangeability.

The entire assembly may be removed from the control instrument for cleaning or repair without disturbing the process, by simply flicking the transfer valve to the "service" position, disconnecting a single air line, and removing four screws.

A minimum of tubing connections eliminates air leakage troubles. Absolute alignment of pen and index is certain throughout the range since both index and input links swing on a common center. Valve action is easily reversible without altering link relationships. The pen faithfully tracks the set point throughout the 0 to 200 per cent throttling range adjustment.

Reset is calibrated accurately from 0.2 to 50 min, guaranteeing "on the beam" results the moment the controller goes on stream, the manufacturer states.

(9) Sand, gravel pump

As it is literally impossible to prevent wearing of parts in a pump handling solids consisting of gravel, sand, grit, etc., engineers of the new "Lightning" pumps did the next best thing. By designing and perfecting a method of securing front and back side plates without bolts, they made disassembly and parts replacement a relatively easy matter. At the same time, the absence of bolt holes in the shell tends to strengthen and lengthen the service life of the shell. The new design makes possible the very desirable close tolerance of 1/64 in. between impeller and suction liner, thus practically eliminating the entrance of abrasive materials. All wearing parts of the pump are cast of a new alloy called Hi-Chro-Hi, a white, semi-steel. Overhaul of the pump is reduced to a basically simple operation which can, if necessary, be performed by a layman.

The Kansas City Hay Press Company is the manufacturer.

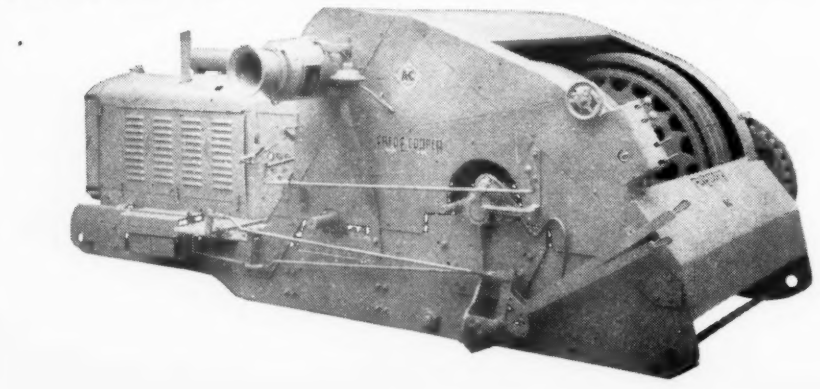
(10) Unitized drawworks

A single-drum, self-powered and unitized drawworks, identified as Cooper-Allis Chalmers Model L844-52-in. drawworks, has been designed for drilling 4000-6000-ft holes and handling workover jobs to 10,000 ft.

This unit features newly designed air controls, with finger tip convenience. The clutches are positive dental type, air actuated, and all moving parts are Timken bearing mounted. The Cooper, patented, circulating air-cooled brakes on this unit are 52-in. diam by 10-in. width. Each brake has two 5-in. equalized bands and each brake is equalized.

The drum drives are so arranged that no chain is idling during any operation. Drums are free rolling with eight pulling speeds. Capacity of the L844-52-in. is 13,000 ft of ¾-in. line. The unit is powered by a 6-cylinder L844 engine, developing 590 ft-lb torque at 700 rpm.

This unit is available with rotary drive, catheads, cross-arm spudder, mast, and two or three drums.



How to save production costs —JENSEN

Production costs are made up of many things—labor, materials, repairs, service and others.

A lot of your money goes into the purchase, operation and maintenance of the pumping unit—and it's here that a Jensen will save production costs. The initial cost is reasonable due to mass production; repairs and maintenance are less because of extensive field testing with thousands in use all over the world; and lower power costs thanks to the use of roller bearings and fewer moving parts.

Further information on how Jensens save production costs is available through your dealer or by writing to Coffeyville. Check up today.

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Export Office: 50 CHURCH STREET
NEW YORK CITY

What's in a name? PLENTY!

Have you ever stopped to analyze this name?...

THE NAME *"Shaffer Combination Rotating Blow-Out Preventer and Stripper"* **is a long one — *but actually it's not long enough to even begin to outline the many unique features incorporated into this unusually complete pressure control unit.***

FIRST, CONSIDER THE WORDS "COMBINATION BLOW-OUT PREVENTER AND STRIPPER": Unlike conventional pressure control equipment, this unit is BOTH a Blow-Out Preventer and a Stripper — combined into *one* compact unit. As a Blow-Out Preventer it maintains a *continuous* pressure-tight seal around *any* and *all* shapes and diameters* in the drill string — whether square, hexagon or octagon kellys... flush or upset pipe, couplings, tool joints or drill collars. That in itself is a very important advantage!

AND NOT ONLY DOES IT MAINTAIN THIS SEAL CONTINUOUSLY, but it also adjusts itself *instantly* and *automatically* to varying shapes and diameters as they pass through the unit — *all without manual attention of any kind.* Therefore it is a "Stripper" in the fullest sense of the word — a Stripper that *automatically* maintains complete pressure control even while the drill string is raised or lowered through the unit—*and no special pipe handling procedures are necessary.* So that's another very important advantage!

HOW ABOUT THAT WORD "ROTATING"? It highlights still another vital feature, for this unit is not only both a Blow-Out Preventer and a Stripper, but it also maintains complete pressure control *while the drill string is rotating.* It even maintains a leak-proof seal around *all* types of kellys while they rotate — even square ones — without damage or wear on the Stripper Rubber!

You see, the kelly and Stripper Rubber rotate *together* — not one inside the other. This eliminates continuous wear and flexing of the Stripper Rubber, yet permits rotation to be maintained while the drill string is sealed off *at all times* against pressure emergencies. It's obvious that this is a very important advantage, too!

AND OF COURSE THAT WORD "SHAFFER" is mighty important because it tells you that this unit is backed by pioneers in the development of high pressure control equipment — an organization with a *quarter of a century* of leadership, experience and integrity behind every product it makes.

**Excepting such abnormally large diameters as reamer or bit.*

Actually the name is not long enough...

It doesn't indicate how the Shaffer Combination Rotating Blow-Out Preventer and Stripper is completely *automatic in its action, always maintaining its full pressure seal without manual operations of any kind. No valves to turn, nothing to tighten or loosen, no operations to remember — or forget — when pressure emergencies arise. It is* always *sealed around the drill string!*

And the name doesn't even hint at such other vital features as the unique bearing design *that assures smooth wobble-free rotation without maintenance... or the pre-packed* lifetime *bearing lubrication... or the special barrier of expandable steel latches that safeguard the Stripper Rubber against damage by large diameters, and against extrusion by high pressures... or the simple way in which such large tools as bits and reamers can be readily passed through the unit by simply pulling a latch and rotating the bonnet 1/6th turn to open the body to full casing diameter.*

In fact, although we have mentioned only a few of the many really unique features combined into the Shaffer Combination Rotating Blow-Out Preventer and Stripper, you can readily see that the name isn't half long enough. Before you invest in any pressure control equipment, why not let us give you the *complete* story on this versatile, trouble-free, highly-efficient Shaffer product?

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OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

Write for your free copy of the Shaffer Catalog. See pages 3843 to 3894 of your 1948 Composite Catalog for data on the full Shaffer line.

(11) Electrical wire

A new electrical wire with rubber insulation that improves when soaked in water has been developed by United States Rubber Company for wiring homes, factories, offices, and other buildings.

The new wire is designed for use underground and in wet locations where high moisture resistance gives it longer life and increased safety. It is particularly suitable for underground lead-ins and wiring damp basements.

Secret of the wire's durability is a coating of high purity natural rubber latex applied by the dip process.

Tests conducted by Underwriters' Laboratories, Inc., where the wire was immersed in water at a temperature of 122 F for 24 weeks, showed an insulation resistance curve that rose from 500 megohms to 2400 megohms per 1000 ft of wire. A normal insulation resistance curve shows a sharp drop after two to four weeks immersion.

In addition to greater moisture resistance, the insulation of the new wire has improved tensile strength and elongation. It is being marketed under the trade name "Laytex RUW."

(12) Paint stripper

A new, cold solvent material, Oakite Composition No. 15 designed to permit fast, thorough removal of paint and similar finishes from metal surfaces, has recently been announced by Oakite Products, Inc. Oakite Composition No. 15, the manufacturers report, has demonstrated pronounced effectiveness in removing baking japans, wrinkle finishes, nitrocellulose lacquers, and synthetics such as alkyds, phenolics, ureas, vinyls, etc., from such metal as steel, galvanized iron, die castings, aluminum, copper and brass, with no attack on the metal.

Designed for use at room temperature, Oakite Composition No. 15 may be applied by tank immersion method or by swabbing or brushing. This is followed by hot pressure-rinse to remove loosened paint particles. An outstanding use for this material is production stripping of rejects.

(13) Castable refractories

Johns-Manville has announced the development by its research laboratory of two new castable refractories for service temperatures up to 3000 F. They are 3X Firecrete and 3X Blazecrete. According to N. J. Kent, manager of Johns-Manville refractory products, the use of these fast air-hardening refractories offers substantial savings in furnace construction costs because of their adaptability for application by casting, gunning and troweling.

The 3X Firecrete is recommended for casting or pouring special refractory shapes of all descriptions — burner blocks, door linings, furnace covers, and complete linings. It is handled as easily as ordinary concrete.

The 3X Blazecrete, while classified as a castable refractory (because it is hydraulic setting) was especially developed for pneumatic application in which it is "shot" in place by compressed air with guns. Gunning is used to advantage in new construction and also for repairs.

Kent points out that these new refractory products help reduce outage hours in furnaces because they air harden quickly and can be ready for service within 24 hr after installation. Both have negligible shrinkage from application to soaking temperatures of 3000 F and possess unusually high spall resistance.

(14) Electrostatic voltmeter

A new portable electrostatic voltmeter designed to meet the need for a high-impedance, high-voltage instrument in laboratory and industrial testing, has been announced by General Electric's meter and instrument divisions.

Available in five ratings—40, 50, 60, 70, and 75-kv, rms—the instrument can be used to measure applied voltage during dielectric test, to study electric phenomena, to determine peak voltage by the vacuum-tube method, to measure exceptionally high voltage when used with a voltage divider, and to determine the peak voltage output of magnetos.

Housed in a cylindrical steel case 21½ in. in diam, it weighs approximately 50 lb. The high-voltage connector projects about 12 in. above the top of the 35-in. high case.

The moving system consists of two fixed electrodes between two small metal spheres that revolve on a pivoted shaft on which are mounted aluminum damp-

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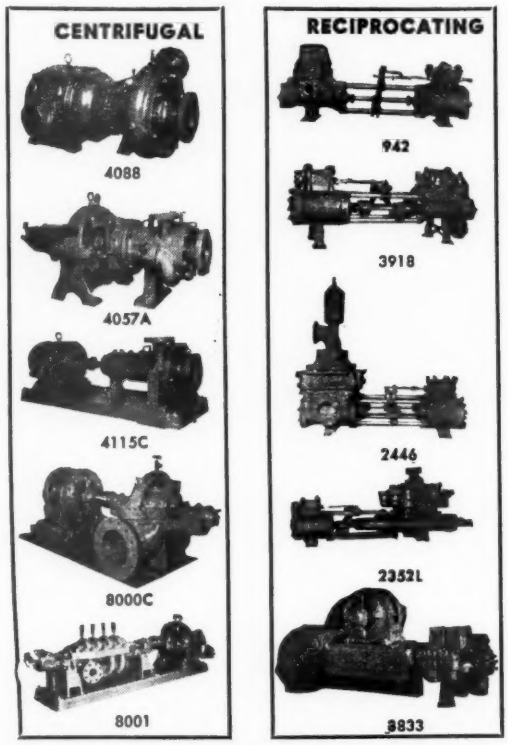


BRANCH OFFICES: NEW YORK HOUSTON

ing vanes, a mirror, and a spring. The mirror reflects a beam of light onto the scale, indicating the position of the moving electrode.

The moving system is insulated from the case and is connected to the high-voltage terminals through a current-limiting resistor that serves as a protective device when voltages in excess of flash-over values accidentally are applied.

A minimum number of insulating supports are used between the moving system and the case to permit the insulation resistance to be as high as possible. The top insulating plate upon which the resistor housing is mounted is made of plexiglass to allow inspection of the moving element without disassembling the instrument.

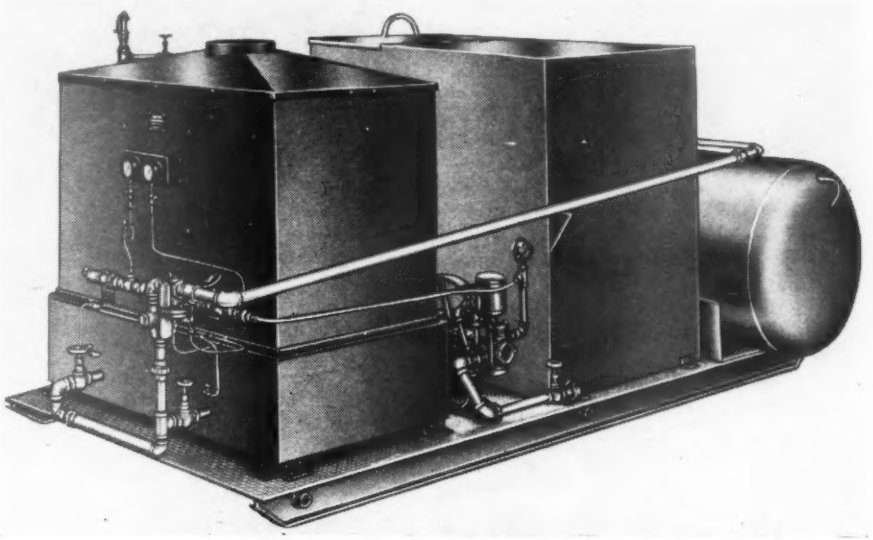
(15) Generator-cleaner

Ewing Manufacturing Company has introduced a large size heavy duty steam generator-cleaner, called Model OF-400, which, according to the company, is proving especially effective in cutting paraffin, low melt asphalts, and sludges. Tests conducted on pumping wells in the Permian Basin area of New Mexico and West Texas, where paraffin deposits create headaches for operators, have been very satisfactory. The Ewing unit produces up to 150 psi pressure at 300 to 400 F and the steam penetrates several hundred feet into the hole where paraffin clogging is most prevalent.

The device has also been tested extensively with good results in cleaning flow and lead lines, tubing, storage tanks, and various containers. Low-melt asphalts and sludges respond to Ewing's high pressure steam at 300-400 F levels, depending, of course, upon chemical content and melting point of the substances encountered.

Ewing, who has been making steam cleaning equipment exclusively for more than 23 years, equips this generator-cleaner with a butane heating element although natural gas may be used. It has a heavy weight, double steel shell with thick asbestos lining. Coils are of best steel tubing. It is equipped with thermostat, 200-psi pop valve, and automatic pressure-stat, plus 300-psi test steel connections. The unit is 5 by 5 by 10 ft, weighs approximately 2500 lb, and is skid mounted. It offers extra steam capacity for cleaning uses because it provides outlets for two heavy-duty steam hoses. Equipment includes 200-gal. butane tank, 400-gal. water tank, 50-gal. cleaning solution tank, and Deming piston-type water pump, powered by a Briggs and Stratton gasoline engine.

About four minutes time allows for creation of steam and plentiful hot water for numerous uses.



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Two thousand years ago the Chinese used a rig similar to the one illustrated to drill wells for brine, sometimes reaching to a depth of 2000 feet. This ancient apparatus contained most of the basic features of cable tool rigs used today.

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(16) Silicon bronze electrode

The Air Reduction Sales Company has announced the immediate availability of the new silicon bronze electrode. According to the manufacturer, these electrodes may be used for the welding of silicon bronze base metal, copper, and for joining galvanized iron and silicon bronze to steel. According to Air Reduction the new electrode offers the following advantages:

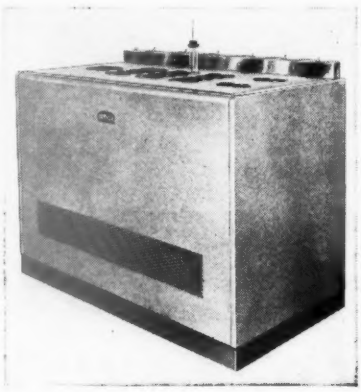
1. Soft, spray type, shielded arc action.
2. Very low spatter loss.
3. Exceptional free flowing, dense deposit.
4. Very easy slag removal.
5. Crack-free welds.
6. Unusually smooth deposits.
7. All position welding.
8. Ability to weld silicon bronze, copper, iron base and dissimilar metals.

The new Airco silicon bronze electrode is available in 5 diameters ranging from 3/32-in. to ¼-in. and varying in length from 11 to 18 in. The new electrode may be purchased in standard 50-lb packages.

(17) Cloud, pour test

A new cloud and pour test unit is in production at Bowser, Inc., Refrigeration Division, according to E. S. Ronk, general manager. The unit conforms with ASTM, API, and ASA standards for all cloud and pour testing.

It is unusual in that two more temperature factors, plus 77 F, plus 118 F (as outlined in the Procedure for Pour Point, Par. 5C ASTM Spec. D97-47), and an adjustable factor from minus 60 F to



minus 80 F for determination of very low pour points have been provided for complete testing in one unit.

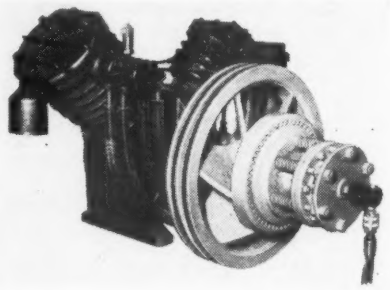
Stainless steel tanks contain 32 copper sleeve test tube inserts with four sleeves from minus 60 F to minus 80 F, eight at minus 30 F, eight at 0 F, eight at plus 30 F, two at plus 77 F, and two at plus 118 F. Temperatures are controlled by built-in thermostats.

The cabinet measures 52 in. wide by 39 in. high by 27 in. deep. Current required is 110 volt, 60 cycle, S. Ph., A. C. Refrigeration is provided by a self-contained, two-stage, air-cooled condensing unit.

(18) Air compressor clutch

A completely automatic air compressor clutch recently developed by the Wichita Falls Foundry and Machine Company is now in production. The clutch reaches a new high in efficiency, requiring no attention from the operator, starting and stopping at any desired maximum and minimum pressure, according to the manufacturer.

Intended for heavy duty use, it has six strong springs to provide simple,



positive, automatic engagement. Air pressure acts on a diaphragm, when pressure operates the unloader, to disengage the clutch. The Wichita air compressor clutch is designed to be easily accessible at all times and may be mounted with the air compressor at the outer end of the power unit output shaft and driven by a V-belt pulley on the output shaft.

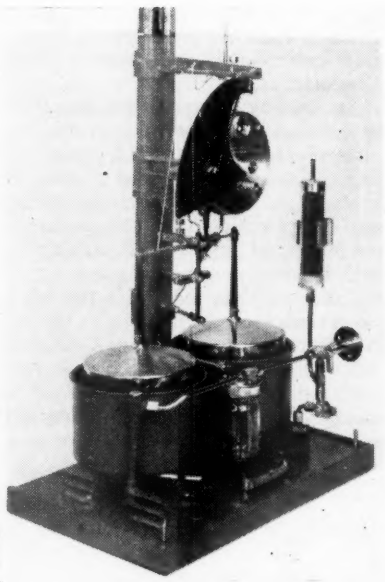
(19) Gravitometer

For determining and recording the specific gravity of gases automatically corrected to the humidity content of the air, the American Recording Chart Company has perfected a new Arcco-Anubis gas gravitometer. This new double column precision instrument is built to conform to the recommendations of the National Bureau of Standards. It measures the difference in weight between a column of gas and an equal column of dry air—the ratio representing the true specific gravity of the sample.

In operation, one bell of the instrument is filled with the gas sample that is being measured, and the other bell is filled with dry air. Tell-tale silica gel is used as a drier in the dry air column. The difference in weight between the two columns acts on the head of the "working bell," raising or depressing it as the gas is heavier or lighter than the air. This force is resisted by the weight of a pendulum that moves, and allows the pen mechanism to move, in direct ratio to the specific gravity of the gas sample.

In this new dry air gas gravitometer the element of human and mechanical error has been reduced to a minimum. There are no electric motors, pressure regulating devices, or other mechanical complexities. It is further asserted that neither temperature changes, nor moderate vibrations, have any adverse effect on the accuracy of the records. Even under extreme conditions of temperature the specific gravity record is automatically corrected to 60 F.

When calibrated and properly installed, the dry air gas gravitometer requires little attention other than to wind the clock, ink the pen, and change the charts. It has been subjected to the most exacting kind of practical service tests and is highly acclaimed for its extremely high degree of accuracy and dependability, according to the manufacturer.

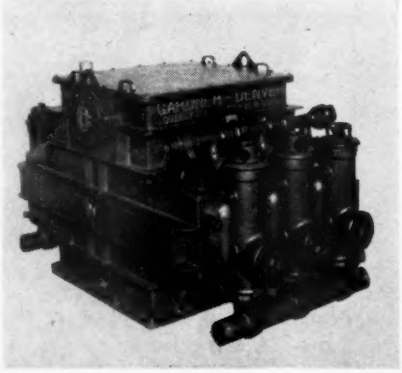


(20) Power pump

A new super-pressure oil well servicing pump capable of maintaining pressures up to 10,000 psi, has been announced by the Gardner-Denver Company. In its design, the new pump incorporates a number of new features. Unusual compactness is obtained by the arrangement of the cylinders. The pump has 6 cylinders arranged in 2 triplex single-acting plunger pumps. One bank of 3 plungers is 3½ in. diam and the other is 4¾ in., both with a 7-in. stroke.

A unique feature is the fact that the pump is designed for operation with either or both ends simultaneously, thus permitting a wide range of volume and pressure. Low pressure work is handled with a volume of more than 250 gpm, using all 6 plungers. High pressure and small volume work is done with either bank of 3 cylinders. More than 200 gpm can be pumped at 1000 psi or approximately 25 gpm at 8000 psi.

Another unusual feature is the use of scotch yokes to convert rotary motion of the main shaft eccentric into reciprocating motion of the plunger.



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Locating hole in blade is patented Hunt feature.
Special alloy slush nozzles.
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Locating pin on bit axis positions blade properly.

Any previous possibility of error in blade replacement has been completely eliminated in the Hunt Export Model Welded-in Blade Bit. This Hunt improvement enables crews to accurately replace blades right in the field. Hunt Export Model Welded-in Blade Drilling Bits are made in two, three and four-way types.

Hunt Export Model Welded-in Blade Bits offer these new features, along with a new standard for drilling efficiency. With this remarkable new style bit, you save valuable time . . . costly errors . . . can stock blades at remote locations . . . you are assured maximum, full-gauge hole with each bit.

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trade literature

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(21) Hard surfacing electrodes

The Page Steel and Wire Division of American Chain and Cable Company, Inc., has issued a new booklet DH 45, "Page Hard Surfacing Electrodes," which consists of the following grades: (1) Special manganese nickel shielded arc electrodes; (2) manganese shielded arc electrodes; (3) manganese nickel bare electrodes; (4) high carbon shielded arc electrodes, and (5) medium carbon shielded arc electrodes.

Each of these electrodes has been developed to provide a weld metal deposit whose particular properties are suited to definite welding applications and are outstanding in their field.

(22) Oil well pumps

Entitled "A Pump Is No Better Than Its Barrel," the brochure just completed by Fluid Packed Pump Company, is a colorful and comprehensive presentation. Opening with an exposition of the punishment to which oil well pumps are normally subjected, the script outlines the motives that prompted this company to choose the one-piece hardened and honed barrel, without liners, jackets, or extra parts. It then explains all the other considerations and illustrates in detail the process of manufacturing Oilmaster pumps, from the selection of steel, through heat treating, to final inspection. This is a well illustrated and thoroughly interesting account of a modern manufacturing method, as well as a study of the requirements of oil well pumps.

(23) High pressure pumps

The Food Machinery Corporation, Bean-Cutler Division, has released a bulletin on Bean high pressure pumps. Capacities range from 1 to 100 gpm and pressures from 100 to 5000 psi. Some of the uses to which the pumps can be put in the petroleum industry are: (1) Testing of steel pipe, valves, chain, tanks, and other products; (2) water pumping; (3) boiler and pipe line testing; (4) boiler feed service; (5) drilling mud circulation for core drills and oil well drills; (6) boiler cleaning, and (7) pipe line pumping.

(24) Compressors and power units

The Cooper-Bessemer Corporation has prepared and is distributing an attractive folder to give a quick picture of the complete line of the company's compressors and power units and their applications. This is a handy booklet to have for reference purposes.

(25) Wire line stuffingbox

Otis Pressure Control, Inc., has issued a pamphlet on the Otis high pressure wire line stuffingbox. The pamphlet states that this is the identical 10,000-psi stuffingbox used by Otis wire line specialists to run and pull Otis subsurface controls, and to perform routine and emergency wire line operations and services under virtually every conceivable pressure condition. Engineering data, construction and operating details are given.

(26) Description of products

Distribution of a richly bound 148-page catalog that includes complete descriptions and prices on all Weco, Chiksan, and Okadee products is now being made by Well Equipment Manufacturing Corporation. The catalog includes a 28-page section on Weco products, a 50-page section on Chiksan products, and a 60-page section on Okadee valves. Prices on all products are included in the catalogs.

The three catalogs, plus an individual 16-page price booklet on Okadee valves and latest resale discount sheets, are bound into a common imitation black leather binder.

(27) Gas scrubbers and coolers

A new 3-color bulletin, No. H-203, on gas scrubbers and coolers has been released by Peabody Engineering Corporation. Complete with diagrammatic sections, illustrations explaining both the multi-stage and single-stage scrubber and cooler, the new Peabody bulletin also carries diagrams of the Peabody impingement baffle-plate action and actual performance.

(28) Centennial booklet

To commemorate the 100th anniversary of the founding of its plant at Ansonia, Connecticut, Farrel-Birmingham Company, Inc., has released a centennial booklet. In six main divisions of 32 pages of material, the booklet strikes a nice balance in complete subject coverage and good readership. The present-day status of the company is accented, although historical data is adequate and due tribute is given to the founders and to those responsible for the early progress of both the Farrel and Birmingham interests of the company which were merged in 1927.

On the cover a silver centennial seal, embossed on a blue background, gives the booklet impressive identification. Interest in the contents is pointed up by the liberal use of freehand sketches of plant scenes and company products.

(29) High temperature tube steels

The Babcock and Wilcox Tube Company announces the publication of a new edition of its bulletin on B & W Croloys giving technical data on high-temperature steels for alloy tubes and pipe. The bulletin offers condensed information in chart form on such factors as creep strength, short time tensile strength, oxidation and corrosion resistance, temper embrittlement and minimum physical properties. It is designed as a convenient guide showing some of the materials that are available for processing into tubes and pipe for meeting varied high-temperature requirements.

(30) Variable speed motors

Presentation of new model U.S. Varidrive motors is made in a colorful and facttul bulletin issued by U.S. Electrical Motors, Inc. The Varidrive, which enables a machine operator to obtain infinite speeds, is shown in natural colors in different capacities. This 16-page bulletin is attractively compiled and shows in dramatic form how a variable speed motor can be applied to countless operations, to reduce operator fatigue and appreciably increase production. Interesting graphs and illustrations show new ways in which variable speed can be used with savings in man-hours and in obtaining better production. A diaphanous view of the Varidrive shows the operating principle of the motor. Supplementary drawings in full color detail major improvements in design.

(31) Heat Exchangers

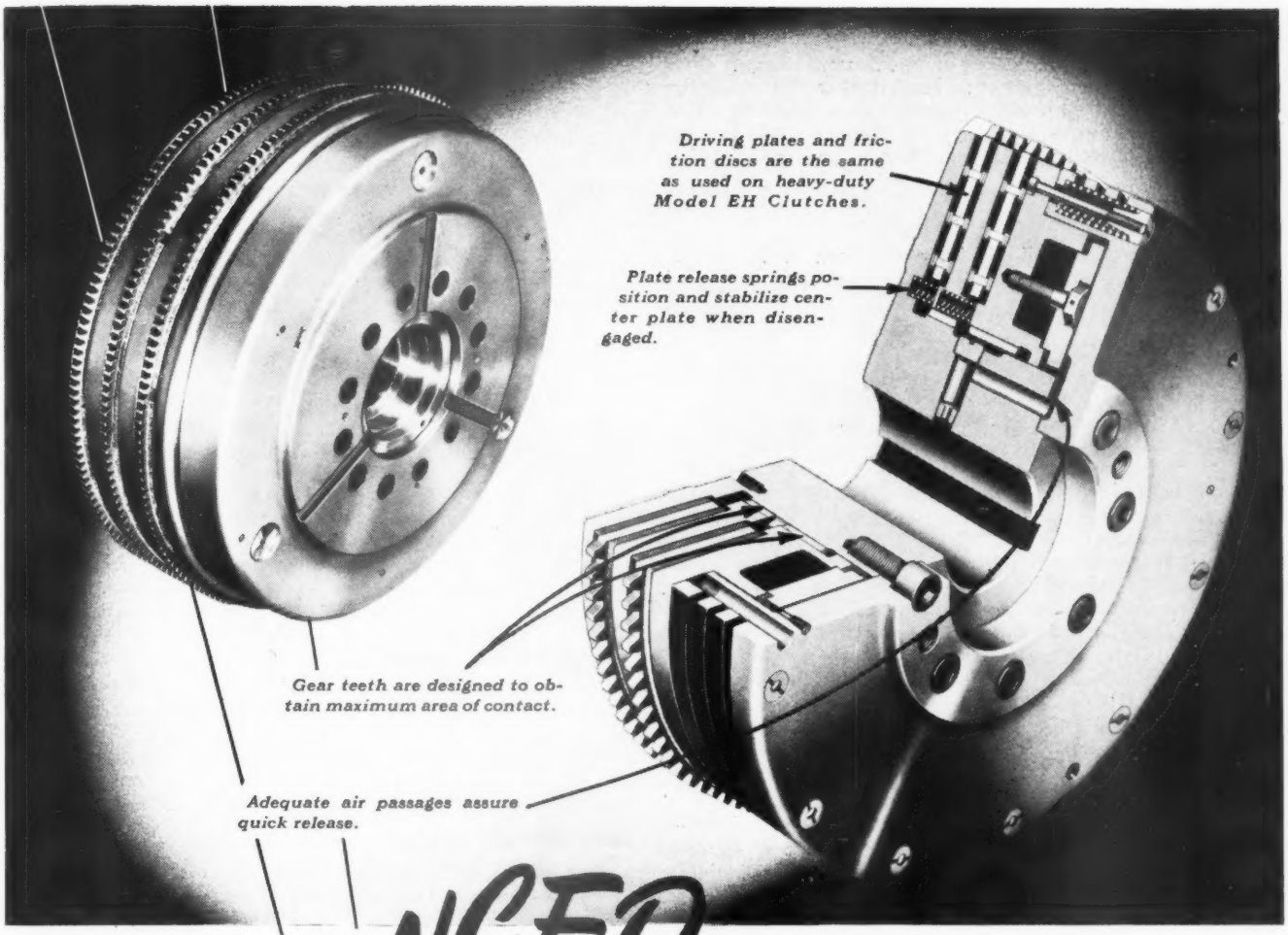
The complete line of Ross shell and tube heat exchangers and allied equipment for all industries may be seen at a glance in a new bulletin published by the manufacturer, Ross Heater and Manufacturing Company, Inc. Illustrations of each major item are supplemented by elaborate cutaways and interior views, and accompanied by brief text on design, construction, and uses.

(32) Digest of news, technical articles

Visco Products Company, Inc., is publishing a quarterly digest of news and technical articles of particular interest to production and refinery men. The Visco Digest is intended to serve as a compact reference source on detailed news and technical information appearing in the large volume of trade journals, news magazines, and scientific publications received by the Visco Library.

(33) Properties of organic chemicals

A new and revised edition of the booklet, "Physical Properties of Synthetic Organic Chemicals," has been issued by Carbide and Carbon Chemicals Corporation, a unit of Union Carbide and Carbon Corporation. This 12-page booklet has been designed as a condensed guide for users of organic chemicals. It contains data on applications and physical properties for more than 185 synthetic organic chemicals. The material is presented in tabular form for ready and easy reference.

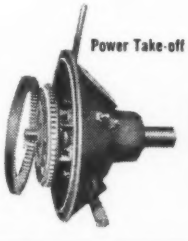

Driving plates and friction discs are the same as used on heavy-duty Model EH Clutches.
Plate release springs position and stabilize center plate when disengaged.
Gear teeth are designed to obtain maximum area of contact.
Adequate air passages assure quick release.

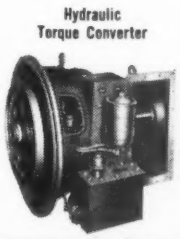
BALANCED ...for work, wear, heat

Experience has proved the mechanical proportions of the Twin Disc Models P and PH Air-actuated Clutches to be in proper balance for efficient work, for long wear-life, and to absorb and dissipate heat . . . essential qualities in heavy-duty clutch installations.

Twin Disc Air-actuated Clutches also permit operation by remote control without complicated linkage systems. They require less shaft space, thereby permitting closer shaft bearing center distances. Gear teeth are designed to obtain maximum area of contact. Multiple springs assure quick release and equal distribution of release pressure. Properly installed, these Clutches require no adjustments to maintain the correct pressure on the friction discs . . . an important factor in obtaining longer wear-life. Model P and PH Clutches are available in sizes from 14 to 42", capacities from 75 up to 1325 hp.

If you have a heavy-duty clutch application requiring operation by remote control, write the Twin Disc Clutch Company for their engineers' recommendations. Ask for Bulletin No. 139-A. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).





TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U. S. PAT. OFF.

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

(34) Drill collars and kellys

Bulletin No. 353, newly issued by The National Supply Company, describes the qualities of its Ideal drill collars and kellys in terms of its new, modernized manufacturing facilities, which include heat treating equipment for collars up to 54 ft long. Profuse illustrations of the new production line and complete specifications for collars and kellys are included.

(35) Speed-trip power slips

BJ speed-trip power slip is fully described in 12-page illustrated folder issued by the Byron Jackson Co., Oil Tool Division.

(36) Well service bulletin

The Dia-Log Company, a division of the Ford Alexander Corporation, recently issued a bulletin on tubing and casing surveys; drill pipe back-off service, and perforation cleaning service, that should be of extreme interest to all drilling and production superintendents and foremen. The folder explains the function of the Dia-Log in determining tubing and casing condition by wall thickness, outlines the method of application, and states that more than 10,000,000 ft already have been examined by the method. It describes the very unique back-off method that is employed for the recovery of stuck pipe. It has completed more than 800 successful jobs on all sizes of drill pipe, drill collars, and tubing. The know-how of perforation cleaning with string shot is expounded simply but interestingly. This is applicable to all types of perforations in casing, liners or gravel packs, and has been used on 300,000 ft of producing zone. The bulletin gives prices of the various services and all pertinent details.

(37) Molded valve packing

A new Edward catalog section 12-R, describing all types of EValpak die molded packing, has been issued by Edward Valves, Inc. EValpak is supplied in sets with each set containing two types of packing. The top and bottom, or outer, rings of each set are wire inserted jacketed rings whereas the center rings are die molded plastic rings. The bulletin gives full details and prices of EValpak sets for each size and pressure class of Edward steel valves.

(38) Diesels in the oil fields

The expanded demands of oil-field drilling operations are pictorially presented in "Caterpillar Diesels in the Oil Fields," a recent publication of Caterpillar Tractor Company. The booklet highlights economical applications of diesel power in the many and varied phases of oil-field work with dramatic illustrations highlighted in the 8-page publication. Such operations as drilling, slush pit building and equipment transportation are given special treatment.

(39) Diamyl Phenol

The Chemical Division of Koppers Company, Inc., has announced the issuance of a new 24-page booklet describing the properties, uses, and reactions of Diamyl Phenol. Bulletin No. C-8-110 gives information of value to the research chemist, the plant production man, and the purchasing agent. Uses for this versatile organic chemical include the production of additives for lubricating oils, plasticizers, and chemicals for the rubber industry. These and numerous other uses for Diamyl Phenol are described in some detail. The physical and chemical properties of the compound are fully described, and there is included a bibliography of 104 references relating to the chemical reactions and uses of the chemical.

(40) Sample electrodes

Ampco Metal, Inc., is offering to send without charge to welders, three sample rods of Amco-Trode 10 aluminum bronze electrodes so that the welder can prove for himself the versatility of this bronze rod that will weld cast iron, and iron copper-and-nickel-base alloys as well as dissimilar metals.

Heretofore the welder had to stock a number of specialty rods to weld various base metals but by using Ampco-Trode 10, excessive inventories are eliminated, it is asserted.

The welder has a choice of diameters—3/32 in., 1/8 in., 5/32 in., or 3/16 in. but only one diameter rod will be given on this free offer.

(41) Chemical additives for lubricants

"Chemical Additives for Petroleum Lubricants" is the title of a new 20-page educational booklet prepared by the American Cyanamid Company. It explains in non-technical language what additives are, why they are needed, when and where they are used, and how they improve lubricating oils. Numerous simple illustrations serve to assist the reader in understanding these complex subjects.

The booklet covers all the commonly used types of lubricating oil additives, and its novel approach to the additive subject should make it of equal interest to manufacturers, marketers, and users of additive-type lubricating oils.

(42) Drilling rig

Bulletin No. 350, 20 pages, describes and illustrates the Ideal Type 100 Consolidated Rig, which is designed for a maximum of 750 hp input (4400 ft-lb torque) and for drilling to a nominal depth of 10,000 ft with 4½-in. drill pipe; of 12,000 ft with 3½-in. drill pipe. Each unit of the rig is separately illustrated and described, including main frame, transmission, drumshaft, sand reel, catshaft, brakes, featured air-operated friction clutches, controls, drive groups, and other members. Engineering, operating and lubricating specifications are included, as well as a shaft speed diagram and dimensional drawing. The bulletin is released by The National Supply Company.

(43) Stainless piping systems

"Taylor Forge Stainless" provides a new and more economical approach to flanged piping, which the manufacturers report to have decided advantages. Four-page, illustrated Bulletin 483 includes drawings, dimensions and prices of new type fittings and flanges, available in Stainless 304, 347, 316 and other materials. The booklet is published by Taylor Forge & Pipe Works.

(44) Water strainer

A recently published folder (Catalog No. 37) describes the new Duplex Strainer now being manufactured by R-S Products Corporation, Philadelphia. This rugged, compact mechanism provides continuous clean water for industrial, processing, and utility purposes. Its unique feature is the incorporation of two basket strainer units within the main casing, arranged so that either can be cleaned while the other is functioning. The switch from one strainer to the other is accomplished by a single handwheel that operates a positive acting, non-fouling valve.

The booklet shows engineering drawings that indicate part dimensions for the six standard size strainers that range from 4 in. to 24 in. pipe-size service. Semi-log graphs show pressure loss and flow rates.

(45) Durimet 20

An 8-page bulletin has been issued on a high alloy low carbon austenitic stainless steel known as Durimet 20. Introduced just before the war, this alloy has proved to be markedly superior to standard 18-8 stainless steel analyses for certain severe corrosive services, especially in the handling of sulphuric acid, the manufacturer asserts. The Duriron Company, Inc., is the manufacturer.

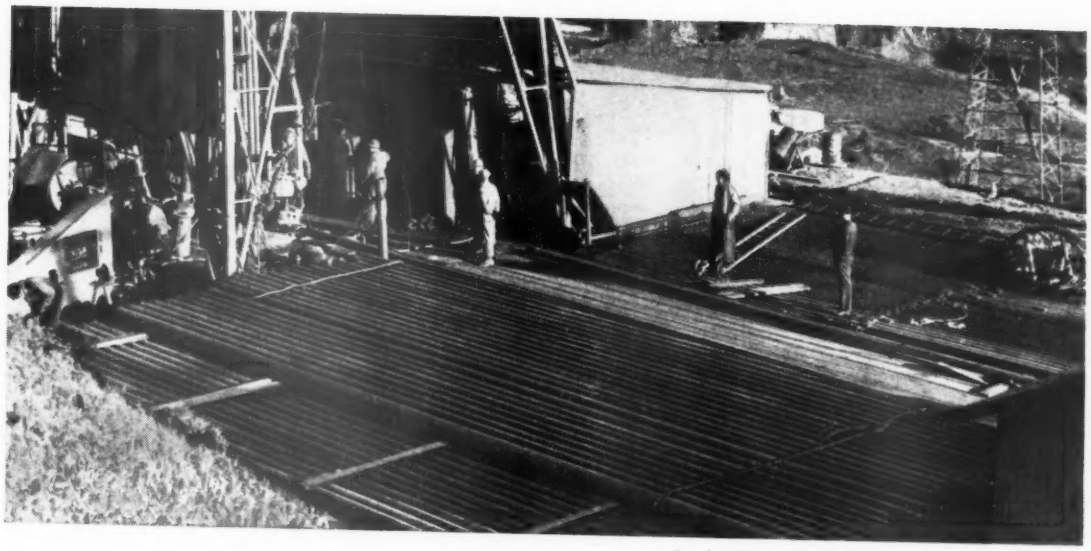
(46) Magna-Tector

Application of the Magna-Tector in locating stuck point of drill pipe, casing, or tubing is described and illustrated in a new 4-page, 2-color brochure. Benefits to the oil operator are explained and many new uses for the Magna-Tector are listed. Several interesting jobs performed by the Magna-Tector are described in detail. Published by McCullough Tool Company.

(47) 30-kc carrier system

Lenkurt Type 32 carrier systems are described in Folder CX39A. This 8-page publication describes the overall system, shows the relationship between maximum performance and minimum maintenance, and displays some of the facilities behind the design, development and manufacture of Lenkurt equipment. Particular emphasis is placed on the filter engineering, which has opened up new spectrum space for use either as a narrow-band voice circuit or with a nine-channel f-m or a-m telegraph system specially designed for this application. It shows how, thus augmented, Lenkurt 32 carrier provides, in effect, a fourth channel.

DEPENDABILITY



In the Ventura (Cal.) field: 7400 feet of 7-inch SMITHway Casing.

THROUGH RESEARCH

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running tour with men in the industry

● **K. E. Beall** has been elected to the office of vice president, economics department, Phillips Petroleum Company. Beall succeeds **J. M. Sands** who reached retirement age this year. Beall joined Phillips in 1920 as a production engineer. Upon the organization of the economics department he transferred to that department and since 1946 he has served as manager.

● **Frank A. Angona,** Dallas, physicist in the field research laboratories of Magnolia Petroleum Company, has been selected to receive one of the two graduate fellowships granted this year by the Socony-Vacuum Oil Company. Selected with Angona was **James Donnelly,** engineer in the Socony-Vacuum research and development laboratories, Paulsboro, New Jersey. The incentive fellowships are awarded annually to two members of the Socony-Vacuum and affiliated organizations on a competitive basis among all technical employes with a minimum of two years' service.

● **L. B. Snedden** has been promoted to assistant manager of the geophysical division, Producing Department, The Texas Company. Snedden, who will have headquarters in Houston, Texas, has been stationed at Bakersfield, California, where he was district geologist and supervisor of geophysical operations in California.

● **Thomas B. Malloy,** field engineer at Woodsboro, Texas, for Stanolind Oil and Gas Company, is now a petroleum engineer at the southwest Texas district office at Corpus Christi. **Robert C. Hagens,** petroleum engineer in the Woodsboro area, succeeds him as field engineer. **Robert O. Williams,** petroleum engineer at Corpus Christi, now holds a similar position in the Houston division office. **John W. Lord,** petroleum engineer in the Luby area, Robstown, Texas, is the new field engineer in the Luby area.

● **George W. Hall** of the Weatherford Spring Company, Weatherford, Texas, recently returned from a four months' trip to the oil fields of Iran, Iraq, Kuwait, and Saudi-Arabia, inspecting Weatherford Spring oil well cementing installations at these points. Leaving Weatherford on January 6, he flew to London, thence to Kuwait on the Persian Gulf. From Kuwait, he made inspection tours of oil fields at Masjid i Sulaiman, White Oil Springs, Haft Kel, Lali, Ahwaz, Agha Jari, and the refinery at Abadan, all in Iran. Later he inspected the fields at Dhahran of Saudi Arabia, and Bahrein Island in the Persian Gulf. The proximity of the Kuwait fields to the USSR prompted Hall to inquire into the relationship between the natives and the Russians. Those questioned answered briefly and pointedly: "Moszane", which is roughly translated "No good!"

● **Robert W. Eiler,** secretary and general attorney of The National Supply Company, has been elected a director of the company. A graduate of Cornell University law school, he practiced law in Chicago and Pittsburgh. He became general attorney for National Supply in 1937 and was elected secretary of the company two years later. He is also secretary and director of the National Supply Export Corporation, National Supply Company, Ltd., and National Supply Construction Corporation, and is a director of Fretz-Moon Tube Company, of Butler, Pennsylvania. He replaces **Charles R. Barton** retired, on National Supply's board of directors.

● **C. G. Kirkbride,** director of laboratories for Houdry Process Corporation, Philadelphia, Pennsylvania, has been elected vice president in charge of research and development. Kirkbride, a director of the company, has served as laboratories chief since April, 1947. Author of the textbook, "Chemical Engineering Fundamentals," Kirkbride joined Houdry after serving as professor of chemical engineering at the Agricultural and Mechanical College of Texas.

He has had broad experience in the petroleum field, having served as chief of chemical engineering development for the Magnolia Petroleum Company at its Dallas laboratories; assistant director of research for Pan-American Refining Company, and chemical engineer in the Whiting Laboratories of Standard Oil Company of Indiana.

Prominent in oil circles, Kirkbride is a director of the American Institute of Chemical Engineers and is also secretary-treasurer of the Petroleum Chemistry Division, American Chemical Society.

● **Floyd H. Boyer,** Temple Court Building, 628 15th Street, Denver Colorado, has been appointed sales representative for the State of Colorado and Laramie County, Wyoming, by Ampco Metal, Inc., Milwaukee, Wisconsin. Boyer will handle the sale of all Ampco products with the exception of arc and resistance welding electrodes and centrifugal pumps.

● **W. P. Anderson** has been appointed general manager of refineries for Caltex in the East of Suez and Eastern Mediterranean territories. After taking a B. S. degree in chemical engineering from the University of California, Anderson, in 1925, entered the research and development department of the Richmond Refinery of Standard Oil Company of California. After some years in this department, and as foreman of the cracking unit department, in 1936 he went to Bahrein Island in the Persian Gulf as superintendent of the Caltex refinery then being built. Anderson became general manager at Bahrein in 1942 and continued until 1946 when he was transferred to the New York offices of Caltex.

● **Dr. Theodore A. Link** has resigned from his position as chief geologist for Imperial Oil Limited, with which company he has been associated for 29 years, and will engage in consulting practice. He will announce his business address in Toronto, Ontario, and Calgary, Alberta, as soon as established. In the meantime he may be reached at his home address, No. 7 Grenadier Heights, Toronto 3, Ontario, Canada.

● **Frank A. Bohen,** division engineer, refinery and pipe line equipment sales, for Oil Well Supply Company's eastern division, has had his headquarters moved to the division sales office in Chicago, according to an announcement at this U. S. Steel subsidiary's main offices in Dallas, Texas. Bohen has been at the eastern division headquarters in Columbus, Ohio.

● **J. B. Christian** has been promoted to assistant general manager of Trinidad Leaseholds Limited, Trinidad, B. W. I. **H. W. MacNaughton-Jones** has been appointed manager, refinery division, of the same company.

● **Denver R. Williams,** assistant to the manager of the crude oil purchase and sales department of the Ohio Oil Company, has been appointed manager of that department. A native of Findlay, Williams was employed by The Ohio Oil Company immediately after his graduation from Findlay High School in June, 1926. Following three months as a messenger, he was transferred to the transportation department, where he became a stenographer and chief clerk. Later assignments were in the Ohio production division and the president's office. In December, 1932, he was transferred to the crude oil purchase and sales department and in March, 1945, was made assistant to the manager.

● **Simon J. Vos,** manager of Regent Oil Company, Ltd., and acting managing director of Trinidad Leaseholds Limited, both of London, has been appointed a director of Central Mining and Investment Corporation of London.

● **T. C. Borland,** formerly assistant division engineer of the Texas-Louisiana Gulf Coast division of Stanolind Oil and Gas Company, has been promoted to division engineer at Houston, Texas.

● **John S. Boldrick,** formerly division petroleum engineer, has been appointed division superintendent of Humble Oil and Refining Company's Louisiana division office at New Orleans.

To fill Boldrick's previous position the company named **J. C. Posgate,** former assistant division petroleum engineer in New Orleans.

The new assistant petroleum engineer is **H. M. Krause, Jr.** Krause was promoted to the Louisiana division from Humble's home office in Houston, where he was supervising petroleum engineer in the petroleum engineering division.

new and improved machinery and equipment

A REGULAR FEATURE
appearing in
THE *Petroleum* **Engineer**
Irwin-Keasler Building
Dallas 1, Texas

(1) Rotojet cleaner

Greatly increased power is claimed by the Elliott Company, Roto Division, for its new Rotojet Junior cleaners for small tubes. The equipment is designed to remove scale and other deposits from tubes as small as 0.495 in. ID in boilers, condensers, evaporators, superheaters, and other tubular apparatus, quickly and economically.

By the use of newly developed materials and by redesign based upon aerodynamic and hydraulic research, Rotojet Junior tube cleaners are said to develop unusual power, considering their small size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Rotojet motors are available for operation with air or water.

(2) New trailer

The Cleveland Trencher Company has announced its improved Model T-10 equipment and material-hauling trailer. The T-10 is a flat bed, 2-axle front loading model designed for moving overhead shovels, rollers, tractors, cranes, trenchers, bulldozers, backfillers, front end loaders, machinery, pipe, steel, lumber, etc.

Some of the more important features listed by the manufacturer are:

This trailer requires no special type vehicle for the hauling. Any ordinary dump, stake, or tractor truck or rubber-tired industrial tractor will do the job quickly and easily over any terrain on which they will travel.

Extremely low loading height (under 24 in.) minimizes all bridge and overhead wire problems and enables the user to keep within all federal and a majority of state road laws.

Sturdy, quality construction, even weight distribution, generous-size tires and 4-wheel electric brakes under instant control of truck driver at his seat, assure safety and speed on the road.

Front loading and unloading on the model T-10 is accomplished, according to the manufacturer, with a maximum of speed and safety through the unique yet simple design of the trailer front. Two adjustable feet (one on each front corner) controlled by a built-in easily accessible hand-operated hydraulic jack, in front center, permit the easy removal and replacement of the front axle and tongue. These two front feet together with the rear wheels of the trailer give a four point support that minimizes the loading angle and reduces materially the hazards of tipping and slipping.

(3) Industrial engines

Unit construction employed in the design of Hall-Scott industrial engines makes for ease of servicing and insures a minimum loss of time in engine idleness, according to the manufacturer, Hall-Scott Motor Division of ACF-Brill Company, Berkeley 2, California.

Component units, such as water pump, oil pump, oil filter, cylinder head assembly, etc., are attached to the engine as complete assemblies. Each assembly is readily accessible for easy removal and replacement without the necessity of dismantling the entire engine. The unit so removed can be reconditioned at leisure, insuring a better job than if pressed for time due to engine shutdown. The engine meanwhile, fitted with a spare unit, is kept in service. This holds true for the cylinder head, which contains the valves and complete valve actuating mechanism, and for all other units.

Also offered by the same company is the Hall-Scott Model 400 engine that provides the trucking industry with a powerful, dependable, and efficient power unit. The engines are equipped to operate on either butane-propane or gasoline, and are said to develop tremendous power at low engine speeds, pulling big loads at maximum speed.

Get Full Details of August, 1948, Listing—Check and Mail Coupon to

THE PETROLEUM ENGINEER
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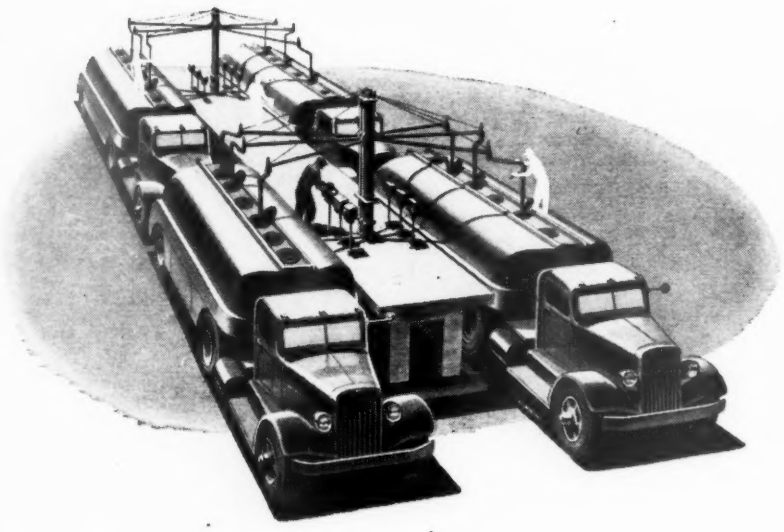
✻ CONTROL TRUCK LOADING AT FOUR STATIONS WITH ONE ATTENDANT, THIS SAFE, FAST, TIME-SAVING WAY

When truck loading meters are equipped with SMITH AUTOMATIC SET STOP and VALVE the delivery is automatically controlled. Simply set the compartment capacity on the predetermining counter and move the control handle. The pump is started and valve opened. When delivery reaches completion the flow is slowed down, topping the compartment — valve closes on **exact** gallon and stops pump. Duplicate tickets are printed showing the exact amount delivered with product identified—your copy providing you with an infallible accounting system. May we tell you more about it?



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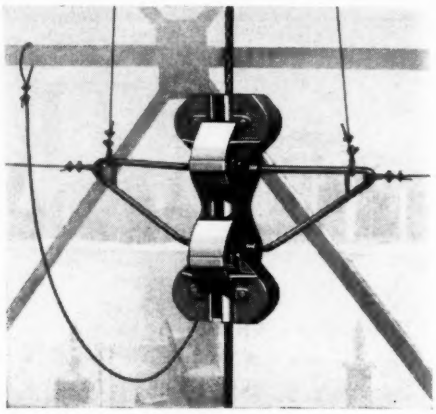
(4) Wire line guide

This new Patterson-Ballagh wire line guide, shown in the accompanying illustration, properly stabilizes wire lines due to the greater overall length and the large number of rollers. Uneven spooling and piling up on the drum is completely eliminated, it is stated. The Roliguide handles both dry and lubricated lines. Each of the eight rollers rotates



on two races of grease packed, overcapacity ball bearings. They absorb the vibration and whip of the wire line and transmit a greater portion of it to the guide body and the hanging assembly.

Rollers are covered with tough, wear-resistant rubber and are completely housed within the body so that no oil can be thrown out on the crew or rig. Replacement parts are quickly and easily installed, it is asserted.

(5) Ribbon anode

New equipment for protecting buried metal structures from corrosion by means of cathodic protection is Galvo-Line, a magnesium ribbon anode that has been developed and tested by the laboratories of The Dow Chemical Company, according to Arthur Smith, Jr., manager of anode sales for that firm.

The new anode has a cross-section of $\frac{3}{8}$ in. by $\frac{3}{4}$ in. and contains a centrally located core of iron wire to facilitate making permanent electrical connections and to prevent possible segregation.

It is designed for use primarily in high resistivity soils where cast anodes may not be practical because of their low current output under such conditions. The magnesium ribbon anode provides faster, simpler, and less expensive methods of installation, it is asserted. In addition it reduces current requirements to a minimum by offering more uniform distribution and better utilization of current from the anode.

Because Galvo-Line's elongated form presents a high area to weight ratio, the new anode supplies from three to seven times as much current per pound of magnesium installed as does the conventional cast anode, it is stated.

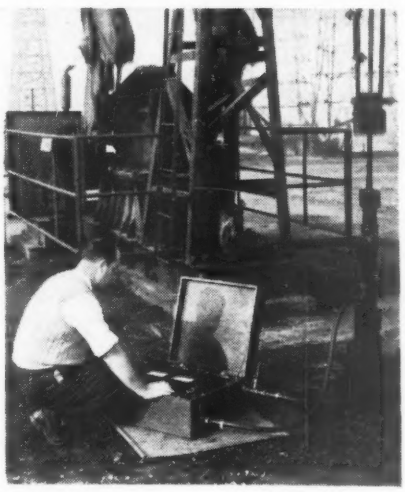
For protection of underground structures the magnesium ribbon can be installed very simply by using a wire-laying plow on which a reel of magnesium ribbon anode is mounted. The anode is installed in a furrow between 16 and 24 in. deep and is spaced some 2 to 10

ft from the structure to be protected. No chemical backfill is necessary and connections are made to such structures as pipe lines about every 500 to 1000 ft where light current flows are expected. If larger current flows are involved, connections must be made at shorter intervals, of course. Whether Galvo-Line is used alone or combined with cast magnesium anodes depends upon the resistivity and uniformity of the soil.

The ribbon anode may also be used successfully as emergency protection for metal structures until more permanent protection programs are put into use, or in very low resistance soils if the rapid polarization provided by the ribbon can justify itself in terms of reduced current demand. Otherwise, the new anode is intended for use in high resistivity soils or in conjunction with cast anodes in order to increase the efficiency and flexibility of cathodic protection installations. The ribbon anode also has many important applications where protection of underwater structures is necessary.

(6) Corrosion in wells

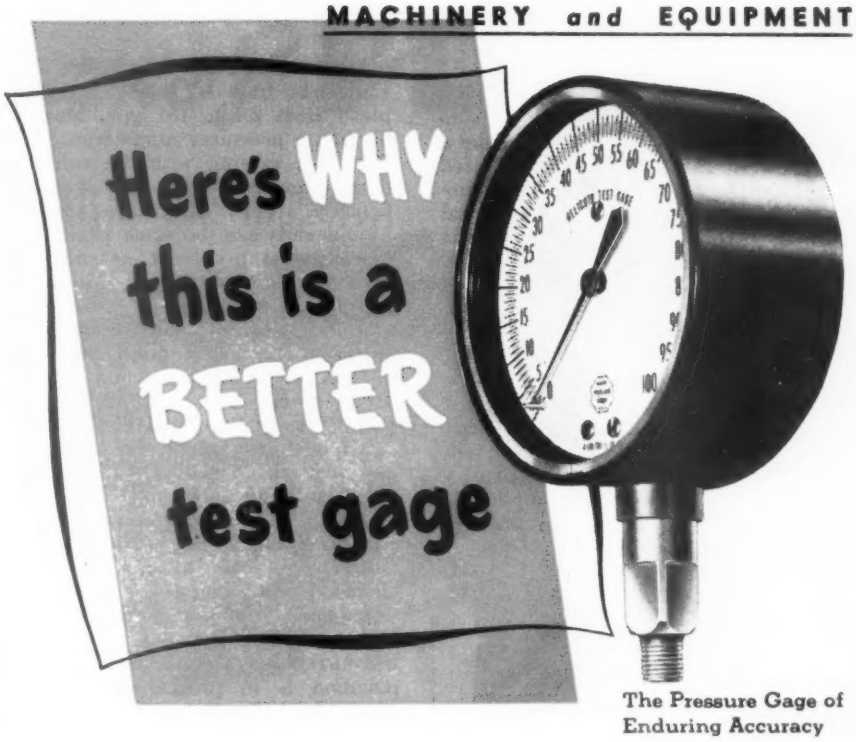
A new method for controlling electro-chemical corrosion on tubing, sucker rods, and pump parts in pumping oil wells has been developed during the last two years by The Cypher System, Inc. This method uses a specially designed mixing device to make a stable emulsion of the oil and brine before it enters the pump. Oil is drawn into the mixer at its lower end and a tail pipe extends downward into the brine, permitting a variation of the oil-brine interface level. Metering orifices in the tail pipe and oil intake maintain a consistent mixture,



which, after being emulsified in the mixer, has a high electrical resistance to the flow of currents generated in the well fluid, thus the electro-chemical corrosion is eliminated or substantially reduced.

The device does not create a costly treating problem. Where demulsifying chemicals have been used at the surface a reduction of treating costs have been noted, which is probably the result of maintaining a constant mixture at the pump.

The effectiveness of the mixing device is determined at the wellhead sample cock with electronic instruments before and after the installation.



The Pressure Gage of Enduring Accuracy

● An example of rugged, durable and weatherproof construction combined with sensitivity and extreme accuracy is the new HELICOID TEST GAGE for Reid Vapor Test Bombs.

May be used for any service where an accurate, portable test gage is required.

4-1/2" dial size—white laminated Phenol durable dials.

Special, phosphor bronze Bourdon tube for greatest torque at low pressures.

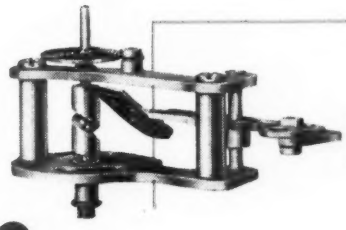
Stainless Helicoid precision movement.

External micrometer pointer adjuster.

Acaloy, flangeless, weatherproof case with rich black baked finish. Stainless steel (18-8) snap ring and Neoprene gasket.

Long, stainless steel (18-8) shank, with square and with 1/4" male pipe thread.

Accuracy guaranteed to within 1/2 of 1%.



Only Helicoid Pressure Gages have the Helicoid Movement

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HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
Bridgeport 2, Connecticut

TRADE MARK

(7) Chemical pump

For use where electric power is not available a new chemical pump, in simplex and duplex models, powered by a 1-hp rotary air motor, is being offered by the Milton Roy Company. This "Airometric" pump is operated by natural gas or compressed air as the prime mover, at air pressures from 50 to 80 psi. A pressure regulator and indicating gage are supplied with each unit to reduce the supply pressure to that required for pump operation. Maximum motor speed is 1750 rpm, held constant by a governor that throttles the air exhaust from the motor. Drive is through a speed reduction unit. The motor and mechanical system are balanced by means of a fly-wheel fixed to the motor coupling.

Maximum pumping capacities are (simplex) from 1.2 to 75.5 gph; (duplex) from 2.4 to 151 gph. Maximum discharge pressures range from 115 to 9500 psi, varying with the volume of liquid pumped. Pumps will operate efficiently at any discharge pressure. Liquid ends are the same positive displacement step-valve construction as used in electrically driven Milton Roy pumps and are available in iron, steel, and alloy metals to meet practically all corrosion resistant requirements. Pumps are accurate metering units affording precise control of volume of liquid pumped to as little as 1 pint per hour.

Applications include the pumping of chemicals in controlled volume and in small quantities, the handling of difficult or corrosive materials, pumping chemicals into flowing oil wells to minimize corrosion, pumping treating chemicals into boilers or boiler feed water lines, or any other purpose where a chemical pump is required and electric current is not available. Another application is in processing operations where explosion hazards prohibit the installation of electrical motors. These units are also applicable as components in chemical feed systems for automatic pH control and similar automatic proportioning purposes.

(8) Pneumatic control

A totally new pneumatic control mechanism is now incorporated into all Fischer and Porter flow controlling instruments. The housing for this new unit consists of a one-piece die casting. This results in all component parts being maintained in a positively fixed relationship to each other.

All important working parts are made from precision castings or heavy stampings, precision trimmed and carefully inspected to assure interchangeability.

The entire assembly may be removed from the control instrument for cleaning or repair without disturbing the process, by simply flicking the transfer valve to the "service" position, disconnecting a single air line, and removing four screws.

A minimum of tubing connections eliminates air leakage troubles. Absolute alignment of pen and index is certain throughout the range since both index and input links swing on a common center. Valve action is easily reversible without altering link relationships. The pen faithfully tracks the set point throughout the 0 to 200 per cent throttling range adjustment.

Reset is calibrated accurately from 0.2 to 50 min, guaranteeing "on the beam" results the moment the controller goes on stream, the manufacturer states.

(9) Sand, gravel pump

As it is literally impossible to prevent wearing of parts in a pump handling solids consisting of gravel, sand, grit, etc., engineers of the new "Lightning" pumps did the next best thing. By designing and perfecting a method of securing front and back side plates without bolts, they made disassembly and parts replacement a relatively easy matter. At the same time, the absence of bolt holes in the shell tends to strengthen and lengthen the service life of the shell. The new design makes possible the very desirable close tolerance of 1/64 in. between impeller and suction liner, thus practically eliminating the entrance of abrasive materials. All wearing parts of the pump are cast of a new alloy called Hi-Chro-Hi, a white, semi-steel. Overhaul of the pump is reduced to a basically simple operation which can, if necessary, be performed by a layman.

The Kansas City Hay Press Company is the manufacturer.

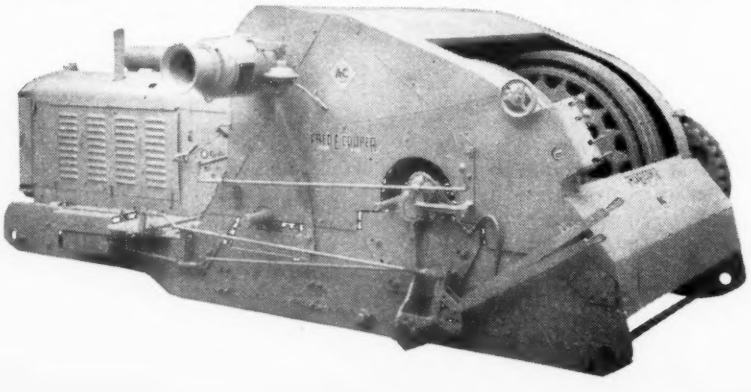
(10) Unitized drawworks

A single-drum, self-powered and unitized drawworks, identified as Cooper-Allis Chalmers Model L844-52-in. drawworks, has been designed for drilling 4000-6000-ft holes and handling workover jobs to 10,000 ft.

This unit features newly designed air controls, with finger tip convenience. The clutches are positive dental type, air actuated, and all moving parts are Timken bearing mounted. The Cooper, patented, circulating air-cooled brakes on this unit are 52-in. diam by 10-in. width. Each brake has two 5-in. equalized bands and each brake is equalized.

The drum drives are so arranged that no chain is idling during any operation. Drums are free rolling with eight pulling speeds. Capacity of the L844-52-in. is 13,000 ft of ¾-in. line. The unit is powered by a 6-cylinder L844 engine, developing 590 ft-lb torque at 700 rpm.

This unit is available with rotary drive, catheads, cross-arm spudder, mast, and two or three drums.



How to save production costs —JENSEN

Production costs are made up of many things—labor, materials, repairs, service and others.

A lot of your money goes into the purchase, operation and maintenance of the pumping unit—and it's here that a Jensen will save production costs. The initial cost is reasonable due to mass production; repairs and maintenance are less because of extensive field testing with thousands in use all over the world; and lower power costs thanks to the use of roller bearings and fewer moving parts.

Further information on how Jensens save production costs is available through your dealer or by writing to Coffeyville. Check up today.

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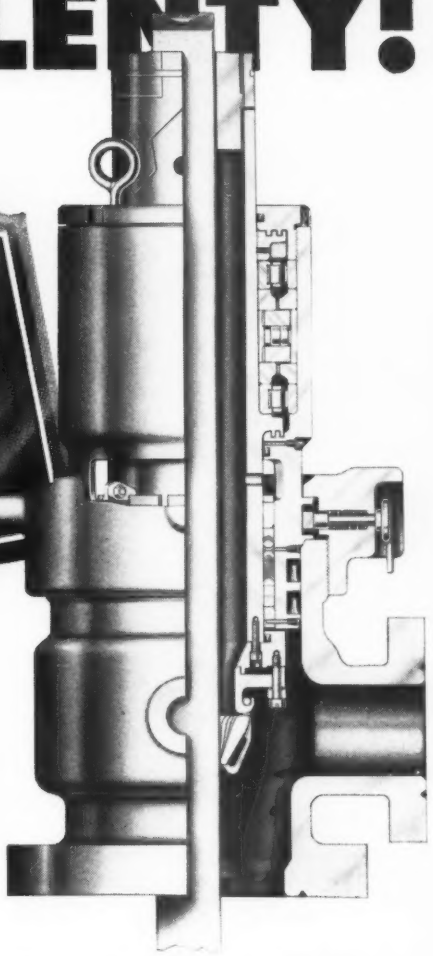
Coffeyville, Kansas, U. S. A.
Export Office: 50 CHURCH STREET
NEW YORK CITY

What's in a name? PLENTY!

Have you ever stopped to analyze this name?...

SHAFFER
COMBINATION
ROTATING BLOW-OUT PREVENTER
AND STRIPPER



THE NAME *"Shaffer Combination Rotating Blow-Out Preventer and Stripper"* is a long one — *but actually it's not long enough to even begin to outline the many unique features incorporated into this unusually complete pressure control unit.*

FIRST, CONSIDER THE WORDS "COMBINATION BLOW-OUT PREVENTER AND STRIPPER": Unlike conventional pressure control equipment, this unit is BOTH a Blow-Out Preventer and a Stripper — combined into *one* compact unit. As a Blow-Out Preventer it maintains a *continuous* pressure-tight seal around *any* and *all* shapes and diameters* in the drill string — whether square, hexagon or octagon kellys... flush or upset pipe, couplings, tool joints or drill collars. That in itself is a very important advantage!

AND NOT ONLY DOES IT MAINTAIN THIS SEAL CONTINUOUSLY, but it also adjusts itself *instantly* and *automatically* to varying shapes and diameters as they pass through the unit — *all without manual attention of any kind.* Therefore it is a "Stripper" in the fullest sense of the word — a Stripper that *automatically* maintains complete pressure control even while the drill string is raised or lowered through the unit—*and no special pipe handling procedures are necessary.* So that's another very important advantage!

HOW ABOUT THAT WORD "ROTATING"? It highlights still another vital feature, for this unit is not only both a Blow-Out Preventer and a Stripper, but it also maintains complete pressure control *while the drill string is rotating.* It even maintains a leak-proof seal around *all* types of kellys while they rotate — even square ones — without damage or wear on the Stripper Rubber!

You see, the kelly and Stripper Rubber rotate *together* — not one inside the other. This eliminates continuous wear and flexing of the Stripper Rubber, yet permits rotation to be maintained while the drill string is sealed off *at all times* against pressure emergencies. It's obvious that this is a very important advantage, too!

AND OF COURSE THAT WORD "SHAFFER" is mighty important because it tells you that this unit is backed by pioneers in the development of high pressure control equipment — an organization with a *quarter of a century* of leadership, experience and integrity behind every product it makes.

**Excepting such abnormally large diameters as reamer or bit.*

Actually the name is not long enough...

It doesn't indicate how the Shaffer Combination Rotating Blow-Out Preventer and Stripper is completely *automatic in its action, always maintaining its full pressure seal without manual operations of any kind. No valves to turn, nothing to tighten or loosen, no operations to remember — or forget — when pressure emergencies arise. It is* always *sealed around the drill string!*

And the name doesn't even hint at such other vital features as the unique bearing design *that assures smooth wobble-free rotation without maintenance... or the pre-packed* lifetime *bearing lubrication... or the special barrier of expandable steel latches that safeguard the Stripper Rubber against damage by large diameters, and against extrusion by high pressures... or the simple way in which such large tools as bits and reamers can be readily passed through the unit by simply pulling a latch and rotating the bonnet 1/6th turn to open the body to full casing diameter.*

In fact, although we have mentioned only a few of the many really unique features combined into the Shaffer Combination Rotating Blow-Out Preventer and Stripper, you can readily see that the name isn't half long enough. Before you invest in any pressure control equipment, why not let us give you the *complete* story on this versatile, trouble-free, highly-efficient Shaffer product?

25 years OF OIL TOOL LEADERSHIP

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

SHAFFER TOOL WORKS: Brea, California • California Service Shops: Santa Fe Springs and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Acme Oil Tool Company, 1001 S. E. 29th Street
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

Write for your free copy of the Shaffer Catalog. See pages 3843 to 3894 of your 1948 Composite Catalog for data on the full Shaffer line.

(11) Electrical wire

A new electrical wire with rubber insulation that improves when soaked in water has been developed by United States Rubber Company for wiring homes, factories, offices, and other buildings.

The new wire is designed for use underground and in wet locations where high moisture resistance gives it longer life and increased safety. It is particularly suitable for underground lead-ins and wiring damp basements.

Secret of the wire's durability is a coating of high purity natural rubber latex applied by the dip process.

Tests conducted by Underwriters' Laboratories, Inc., where the wire was immersed in water at a temperature of 122 F for 24 weeks, showed an insulation resistance curve that rose from 500 megohms to 2400 megohms per 1000 ft of wire. A normal insulation resistance curve shows a sharp drop after two to four weeks immersion.

In addition to greater moisture resistance, the insulation of the new wire has improved tensile strength and elongation. It is being marketed under the trade name "Laytex RUW."

(12) Paint stripper

A new, cold solvent material, Oakite Composition No. 15 designed to permit fast, thorough removal of paint and similar finishes from metal surfaces, has recently been announced by Oakite Products, Inc. Oakite Composition No. 15, the manufacturers report, has demonstrated pronounced effectiveness in removing baking japans, wrinkle finishes, nitrocellulose lacquers, and synthetics such as alkyds, phenolics, ureas, vinyls, etc., from such metal as steel, galvanized iron, die castings, aluminum, copper and brass, with no attack on the metal.

Designed for use at room temperature, Oakite Composition No. 15 may be applied by tank immersion method or by swabbing or brushing. This is followed by hot pressure-rinse to remove loosened paint particles. An outstanding use for this material is production stripping of rejects.

(13) Castable refractories

Johns-Manville has announced the development by its research laboratory of two new castable refractories for service temperatures up to 3000 F. They are 3X Firecrete and 3X Blazecrete. According to N. J. Kent, manager of Johns-Manville refractory products, the use of these fast air-hardening refractories offers substantial savings in furnace construction costs because of their adaptability for application by casting, gunning and troweling.

The 3X Firecrete is recommended for casting or pouring special refractory shapes of all descriptions — burner blocks, door linings, furnace covers, and complete linings. It is handled as easily as ordinary concrete.

The 3X Blazecrete, while classified as a castable refractory (because it is hydraulic setting) was especially developed for pneumatic application in which it is "shot" in place by compressed air with guns. Gunning is used to advantage in new construction and also for repairs.

Kent points out that these new refractory products help reduce outage hours in furnaces because they air harden quickly and can be ready for service within 24 hr after installation. Both have negligible shrinkage from application to soaking temperatures of 3000 F and possess unusually high spall resistance.

(14) Electrostatic voltmeter

A new portable electrostatic voltmeter designed to meet the need for a high-impedance, high-voltage instrument in laboratory and industrial testing, has been announced by General Electric's meter and instrument divisions.

Available in five ratings—40, 50, 60, 70, and 75-kv, rms—the instrument can be used to measure applied voltage during dielectric test, to study electric phenomena, to determine peak voltage by the vacuum-tube method, to measure exceptionally high voltage when used with a voltage divider, and to determine the peak voltage output of magnetos.

Housed in a cylindrical steel case 21½ in. in diam, it weighs approximately 50 lb. The high-voltage connector projects about 12 in. above the top of the 35-in. high case.

The moving system consists of two fixed electrodes between two small metal spheres that revolve on a pivoted shaft on which are mounted aluminum damp-

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DEAN BROTHERS PUMPS INC.

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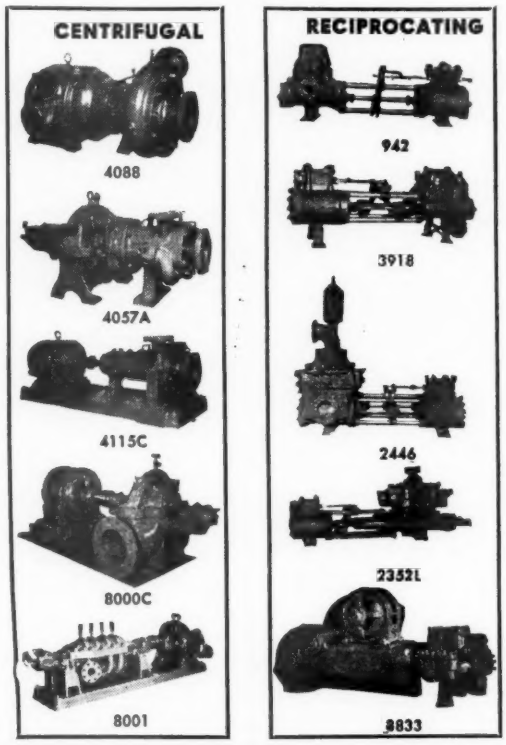


BRANCH OFFICES: NEW YORK HOUSTON

ing vanes, a mirror, and a spring. The mirror reflects a beam of light onto the scale, indicating the position of the moving electrode.

The moving system is insulated from the case and is connected to the high-voltage terminals through a current-limiting resistor that serves as a protective device when voltages in excess of flash-over values accidentally are applied.

A minimum number of insulating supports are used between the moving system and the case to permit the insulation resistance to be as high as possible. The top insulating plate upon which the resistor housing is mounted is made of plexiglass to allow inspection of the moving element without disassembling the instrument.

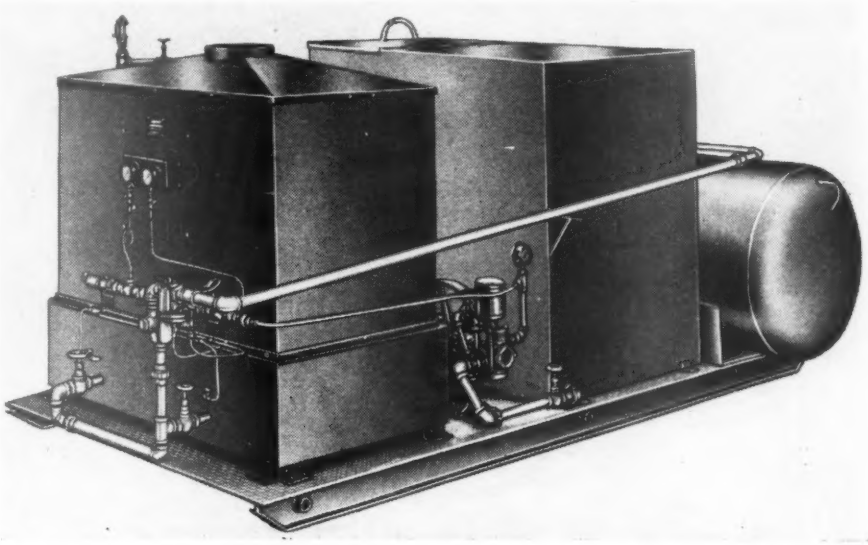
(15) Generator-cleaner

Ewing Manufacturing Company has introduced a large size heavy duty steam generator-cleaner, called Model OF-400, which, according to the company, is proving especially effective in cutting paraffin, low melt asphalts, and sludges. Tests conducted on pumping wells in the Permian Basin area of New Mexico and West Texas, where paraffin deposits create headaches for operators, have been very satisfactory. The Ewing unit produces up to 150 psi pressure at 300 to 400 F and the steam penetrates several hundred feet into the hole where paraffin clogging is most prevalent.

The device has also been tested extensively with good results in cleaning flow and lead lines, tubing, storage tanks, and various containers. Low-melt asphalts and sludges respond to Ewing's high pressure steam at 300-400 F levels, depending, of course, upon chemical content and melting point of the substances encountered.

Ewing, who has been making steam cleaning equipment exclusively for more than 23 years, equips this generator-cleaner with a butane heating element although natural gas may be used. It has a heavy weight, double steel shell with thick asbestos lining. Coils are of best steel tubing. It is equipped with thermostat, 200-psi pop valve, and automatic pressure-stat, plus 300-psi test steel connections. The unit is 5 by 5 by 10 ft, weighs approximately 2500 lb, and is skid mounted. It offers extra steam capacity for cleaning uses because it provides outlets for two heavy-duty steam hoses. Equipment includes 200-gal. butane tank, 400-gal. water tank, 50-gal. cleaning solution tank, and Deming piston-type water pump, powered by a Briggs and Stratton gasoline engine.

About four minutes time allows for creation of steam and plentiful hot water for numerous uses.



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ANCIENT CHINESE DRILLING RIG

Two thousand years ago the Chinese used a rig similar to the one illustrated to drill wells for brine, sometimes reaching to a depth of 2000 feet. This ancient apparatus contained most of the basic features of cable tool rigs used today.

This 17" x 20" reproduction of an original painting by Frank Chapman Williams will be sent to you without obligation. Use this convenient coupon.

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(16) Silicon bronze electrode

The Air Reduction Sales Company has announced the immediate availability of the new silicon bronze electrode. According to the manufacturer, these electrodes may be used for the welding of silicon bronze base metal, copper, and for joining galvanized iron and silicon bronze to steel. According to Air Reduction the new electrode offers the following advantages:

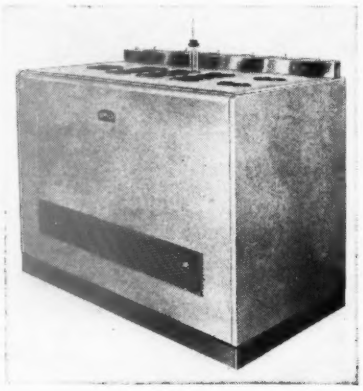
1. Soft, spray type, shielded arc action.
2. Very low spatter loss.
3. Exceptional free flowing, dense deposit.
4. Very easy slag removal.
5. Crack-free welds.
6. Unusually smooth deposits.
7. All position welding.
8. Ability to weld silicon bronze, copper, iron base and dissimilar metals.

The new Airco silicon bronze electrode is available in 5 diameters ranging from 3/32-in. to ¼-in. and varying in length from 11 to 18 in. The new electrode may be purchased in standard 50-lb packages.

(17) Cloud, pour test

A new cloud and pour test unit is in production at Bowser, Inc., Refrigeration Division, according to E. S. Ronk, general manager. The unit conforms with ASTM, API, and ASA standards for all cloud and pour testing.

It is unusual in that two more temperature factors, plus 77 F, plus 118 F (as outlined in the Procedure for Pour Point, Par. 5C ASTM Spec. D97-47), and an adjustable factor from minus 60 F to



minus 80 F for determination of very low pour points have been provided for complete testing in one unit.

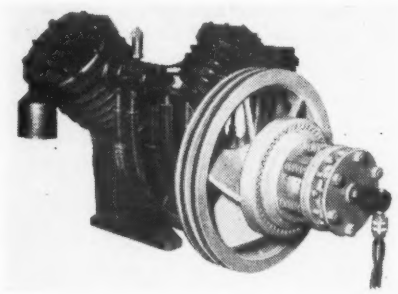
Stainless steel tanks contain 32 copper sleeve test tube inserts with four sleeves from minus 60 F to minus 80 F, eight at minus 30 F, eight at 0 F, eight at plus 30 F, two at plus 77 F, and two at plus 118 F. Temperatures are controlled by built-in thermostats.

The cabinet measures 52 in. wide by 39 in. high by 27 in. deep. Current required is 110 volt, 60 cycle, S. Ph., A. C. Refrigeration is provided by a self-contained, two-stage, air-cooled condensing unit.

(18) Air compressor clutch

A completely automatic air compressor clutch recently developed by the Wichita Falls Foundry and Machine Company is now in production. The clutch reaches a new high in efficiency, requiring no attention from the operator, starting and stopping at any desired maximum and minimum pressure, according to the manufacturer.

Intended for heavy duty use, it has six strong springs to provide simple,



positive, automatic engagement. Air pressure acts on a diaphragm, when pressure operates the unloader, to disengage the clutch. The Wichita air compressor clutch is designed to be easily accessible at all times and may be mounted with the air compressor at the outer end of the power unit output shaft and driven by a V-belt pulley on the output shaft.

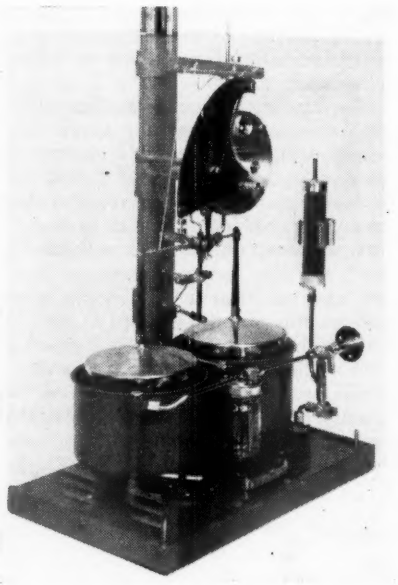
(19) Gravitometer

For determining and recording the specific gravity of gases automatically corrected to the humidity content of the air, the American Recording Chart Company has perfected a new Arcco-Anubis gas gravitometer. This new double column precision instrument is built to conform to the recommendations of the National Bureau of Standards. It measures the difference in weight between a column of gas and an equal column of dry air—the ratio representing the true specific gravity of the sample.

In operation, one bell of the instrument is filled with the gas sample that is being measured, and the other bell is filled with dry air. Tell-tale silica gel is used as a drier in the dry air column. The difference in weight between the two columns acts on the head of the "working bell," raising or depressing it as the gas is heavier or lighter than the air. This force is resisted by the weight of a pendulum that moves, and allows the pen mechanism to move, in direct ratio to the specific gravity of the gas sample.

In this new dry air gas gravitometer the element of human and mechanical error has been reduced to a minimum. There are no electric motors, pressure regulating devices, or other mechanical complexities. It is further asserted that neither temperature changes, nor moderate vibrations, have any adverse effect on the accuracy of the records. Even under extreme conditions of temperature the specific gravity record is automatically corrected to 60 F.

When calibrated and properly installed, the dry air gas gravitometer requires little attention other than to wind the clock, ink the pen, and change the charts. It has been subjected to the most exacting kind of practical service tests and is highly acclaimed for its extremely high degree of accuracy and dependability, according to the manufacturer.

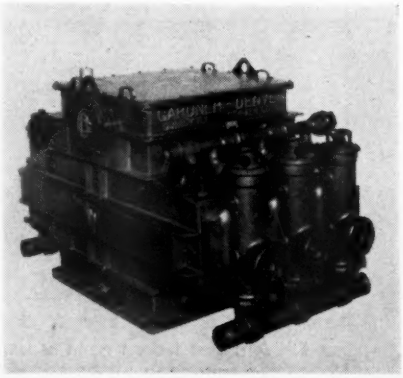


(20) Power pump

A new super-pressure oil well servicing pump capable of maintaining pressures up to 10,000 psi, has been announced by the Gardner-Denver Company. In its design, the new pump incorporates a number of new features. Unusual compactness is obtained by the arrangement of the cylinders. The pump has 6 cylinders arranged in 2 triplex single-acting plunger pumps. One bank of 3 plungers is 3½ in. diam and the other is 4¾ in., both with a 7-in. stroke.

A unique feature is the fact that the pump is designed for operation with either or both ends simultaneously, thus permitting a wide range of volume and pressure. Low pressure work is handled with a volume of more than 250 gpm, using all 6 plungers. High pressure and small volume work is done with either bank of 3 cylinders. More than 200 gpm can be pumped at 1000 psi or approximately 25 gpm at 8000 psi.

Another unusual feature is the use of scotch yokes to convert rotary motion of the main shaft eccentric into reciprocating motion of the plunger.



HUNT EXPORT MODEL WELDED-IN-BLADE BITS

Replace Worn Blades Right in the Field . . .

Three-way
only prop
in head
gauge b
3-way Blade
Locating hole in blade is patented Hunt feature.
Special alloy slush nozzles.
3-way head ready to receive blades . . .
Locating pin on bit axis positions blade properly.

Any previous possibility of error in blade replacement has been completely eliminated in the Hunt Export Model Welded-in Blade Bit. This Hunt improvement enables crews to accurately replace blades right in the field. Hunt Export Model Welded-in Blade Drilling Bits are made in two, three and four-way types.

Hunt Export Model Welded-in Blade Bits offer these new features, along with a new standard for drilling efficiency. With this remarkable new style bit, you save valuable time . . . costly errors . . . can stock blades at remote locations . . . you are assured maximum, full-gauge hole with each bit.

HUNT TOOL COMPANY

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Adva. Pte. R. Saenz Peña 832, Buenos Aires

A BUSINESS BUILT ON SERVICE

trade literature

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(21) Hard surfacing electrodes

The Page Steel and Wire Division of American Chain and Cable Company, Inc., has issued a new booklet DH 45, "Page Hard Surfacing Electrodes," which consists of the following grades: (1) Special manganese nickel shielded arc electrodes; (2) manganese shielded arc electrodes; (3) manganese nickel bare electrodes; (4) high carbon shielded arc electrodes, and (5) medium carbon shielded arc electrodes.

Each of these electrodes has been developed to provide a weld metal deposit whose particular properties are suited to definite welding applications and are outstanding in their field.

(22) Oil well pumps

Entitled "A Pump Is No Better Than Its Barrel," the brochure just completed by Fluid Packed Pump Company, is a colorful and comprehensive presentation. Opening with an exposition of the punishment to which oil well pumps are normally subjected, the script outlines the motives that prompted this company to choose the one-piece hardened and honed barrel, without liners, jackets, or extra parts. It then explains all the other considerations and illustrates in detail the process of manufacturing Oilmaster pumps, from the selection of steel, through heat treating, to final inspection. This is a well illustrated and thoroughly interesting account of a modern manufacturing method, as well as a study of the requirements of oil well pumps.

(23) High pressure pumps

The Food Machinery Corporation, Bean-Cutler Division, has released a bulletin on Bean high pressure pumps. Capacities range from 1 to 100 gpm and pressures from 100 to 5000 psi. Some of the uses to which the pumps can be put in the petroleum industry are: (1) Testing of steel pipe, valves, chain, tanks, and other products; (2) water pumping; (3) boiler and pipe line testing; (4) boiler feed service; (5) drilling mud circulation for core drills and oil well drills; (6) boiler cleaning, and (7) pipe line pumping.

(24) Compressors and power units

The Cooper-Bessemer Corporation has prepared and is distributing an attractive folder to give a quick picture of the complete line of the company's compressors and power units and their applications. This is a handy booklet to have for reference purposes.

(25) Wire line stuffingbox

Otis Pressure Control, Inc., has issued a pamphlet on the Otis high pressure wire line stuffingbox. The pamphlet states that this is the identical 10,000-psi stuffingbox used by Otis wire line specialists to run and pull Otis subsurface controls, and to perform routine and emergency wire line operations and services under virtually every conceivable pressure condition. Engineering data, construction and operating details are given.

(26) Description of products

Distribution of a richly bound 148-page catalog that includes complete descriptions and prices on all Weco, Chiksan, and Okadee products is now being made by Well Equipment Manufacturing Corporation. The catalog includes a 28-page section on Weco products, a 50-page section on Chiksan products, and a 60-page section on Okadee valves. Prices on all products are included in the catalogs.

The three catalogs, plus an individual 16-page price booklet on Okadee valves and latest resale discount sheets, are bound into a common imitation black leather binder.

(27) Gas scrubbers and coolers

A new 3-color bulletin, No. H-203, on gas scrubbers and coolers has been released by Peabody Engineering Corporation. Complete with diagrammatic sections, illustrations explaining both the multi-stage and single-stage scrubber and cooler, the new Peabody bulletin also carries diagrams of the Peabody impingement baffle-plate action and actual performance.

(28) Centennial booklet

To commemorate the 100th anniversary of the founding of its plant at Ansonia, Connecticut, Farrel-Birmingham Company, Inc., has released a centennial booklet. In six main divisions of 32 pages of material, the booklet strikes a nice balance in complete subject coverage and good readership. The present-day status of the company is accented, although historical data is adequate and due tribute is given to the founders and to those responsible for the early progress of both the Farrel and Birmingham interests of the company which were merged in 1927.

On the cover a silver centennial seal, embossed on a blue background, gives the booklet impressive identification. Interest in the contents is pointed up by the liberal use of freehand sketches of plant scenes and company products.

(29) High temperature tube steels

The Babcock and Wilcox Tube Company announces the publication of a new edition of its bulletin on B & W Croloys giving technical data on high-temperature steels for alloy tubes and pipe. The bulletin offers condensed information in chart form on such factors as creep strength, short time tensile strength, oxidation and corrosion resistance, temper embrittlement and minimum physical properties. It is designed as a convenient guide showing some of the materials that are available for processing into tubes and pipe for meeting varied high-temperature requirements.

(30) Variable speed motors

Presentation of new model U.S. Varidrive motors is made in a colorful and factful bulletin issued by U.S. Electrical Motors, Inc. The Varidrive, which enables a machine operator to obtain infinite speeds, is shown in natural colors in different capacities. This 16-page bulletin is attractively compiled and shows in dramatic form how a variable speed motor can be applied to countless operations, to reduce operator fatigue and appreciably increase production. Interesting graphs and illustrations show new ways in which variable speed can be used with savings in man-hours and in obtaining better production. A diaphanous view of the Varidrive shows the operating principle of the motor. Supplementary drawings in full color detail major improvements in design.

(31) Heat Exchangers

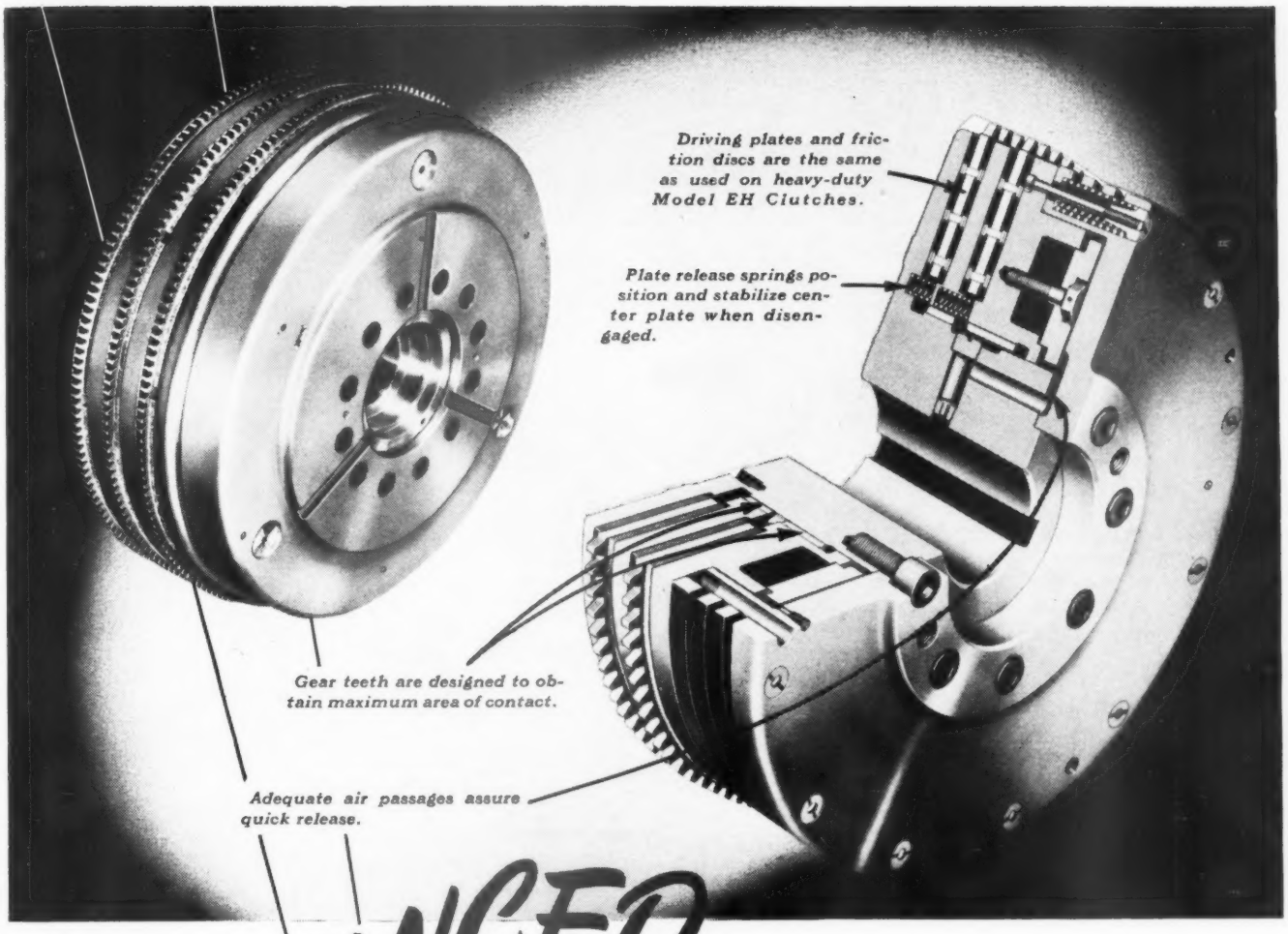
The complete line of Ross shell and tube heat exchangers and allied equipment for all industries may be seen at a glance in a new bulletin published by the manufacturer, Ross Heater and Manufacturing Company, Inc. Illustrations of each major item are supplemented by elaborate cutaways and interior views, and accompanied by brief text on design, construction, and uses.

(32) Digest of news, technical articles

Visco Products Company, Inc., is publishing a quarterly digest of news and technical articles of particular interest to production and refinery men. The Visco Digest is intended to serve as a compact reference source on detailed news and technical information appearing in the large volume of trade journals, news magazines, and scientific publications received by the Visco Library.

(33) Properties of organic chemicals

A new and revised edition of the booklet, "Physical Properties of Synthetic Organic Chemicals," has been issued by Carbide and Carbon Chemicals Corporation, a unit of Union Carbide and Carbon Corporation. This 12-page booklet has been designed as a condensed guide for users of organic chemicals. It contains data on applications and physical properties for more than 185 synthetic organic chemicals. The material is presented in tabular form for ready and easy reference.

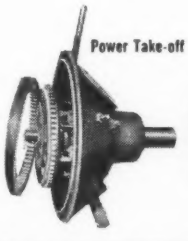

Driving plates and friction discs are the same as used on heavy-duty Model EH Clutches.
Plate release springs position and stabilize center plate when disengaged.
Gear teeth are designed to obtain maximum area of contact.
Adequate air passages assure quick release.

BALANCED ...for work, wear, heat

Experience has proved the mechanical proportions of the Twin Disc Models P and PH Air-actuated Clutches to be in proper balance for efficient work, for long wear-life, and to absorb and dissipate heat . . . essential qualities in heavy-duty clutch installations.

Twin Disc Air-actuated Clutches also permit operation by remote control without complicated linkage systems. They require less shaft space, thereby permitting closer shaft bearing center distances. Gear teeth are designed to obtain maximum area of contact. Multiple springs assure quick release and equal distribution of release pressure. Properly installed, these Clutches require no adjustments to maintain the correct pressure on the friction discs . . . an important factor in obtaining longer wear-life. Model P and PH Clutches are available in sizes from 14 to 42″, capacities from 75 up to 1325 hp.

If you have a heavy-duty clutch application requiring operation by remote control, write the Twin Disc Clutch Company for their engineers' recommendations. Ask for Bulletin No. 139-A. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).



TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U.S. PAT. OFF.

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

(34) Drill collars and kellys

Bulletin No. 353, newly issued by The National Supply Company, describes the qualities of its Ideal drill collars and kellys in terms of its new, modernized manufacturing facilities, which include heat treating equipment for collars up to 54 ft long. Profuse illustrations of the new production line and complete specifications for collars and kellys are included.

(35) Speed-trip power slips

BJ speed-trip power slip is fully described in 12-page illustrated folder issued by the Byron Jackson Co., Oil Tool Division.

(36) Well service bulletin

The Dia-Log Company, a division of the Ford Alexander Corporation, recently issued a bulletin on tubing and casing surveys; drill pipe back-off service, and perforation cleaning service, that should be of extreme interest to all drilling and production superintendents and foremen. The folder explains the function of the Dia-Log in determining tubing and casing condition by wall thickness, outlines the method of application, and states that more than 10,000,000 ft already have been examined by the method. It describes the very unique back-off method that is employed for the recovery of stuck pipe. It has completed more than 800 successful jobs on all sizes of drill pipe, drill collars, and tubing. The know-how of perforation cleaning with string shot is expounded simply but interestingly. This is applicable to all types of perforations in casing, liners or gravel packs, and has been used on 300,000 ft of producing zone. The bulletin gives prices of the various services and all pertinent details.

(37) Molded valve packing

A new Edward catalog section 12-R, describing all types of EValpak die molded packing, has been issued by Edward Valves, Inc. EValpak is supplied in sets with each set containing two types of packing. The top and bottom, or outer, rings of each set are wire inserted jacketed rings whereas the center rings are die molded plastic rings. The bulletin gives full details and prices of EValpak sets for each size and pressure class of Edward steel valves.

(38) Diesels in the oil fields

The expanded demands of oil-field drilling operations are pictorially presented in "Caterpillar Diesels in the Oil Fields," a recent publication of Caterpillar Tractor Company. The booklet highlights economical applications of diesel power in the many and varied phases of oil-field work with dramatic illustrations highlighted in the 8-page publication. Such operations as drilling, slush pit building and equipment transportation are given special treatment.

(39) Diamyl Phenol

The Chemical Division of Koppers Company, Inc., has announced the issuance of a new 24-page booklet describing the properties, uses, and reactions of Diamyl Phenol. Bulletin No. C-8-110 gives information of value to the research chemist, the plant production man, and the purchasing agent. Uses for this versatile organic chemical include the production of additives for lubricating oils, plasticizers, and chemicals for the rubber industry. These and numerous other uses for Diamyl Phenol are described in some detail. The physical and chemical properties of the compound are fully described, and there is included a bibliography of 104 references relating to the chemical reactions and uses of the chemical.

(40) Sample electrodes

Ampco Metal, Inc., is offering to send without charge to welders, three sample rods of Amco-Trode 10 aluminum bronze electrodes so that the welder can prove for himself the versatility of this bronze rod that will weld cast iron, and iron copper-and-nickel-base alloys as well as dissimilar metals.

Heretofore the welder had to stock a number of specialty rods to weld various base metals but by using Ampco-Trode 10, excessive inventories are eliminated, it is asserted.

The welder has a choice of diameters—3/32 in., ⅛ in., 5/32 in., or 3/16 in. but only one diameter rod will be given on this free offer.

(41) Chemical additives for lubricants

"Chemical Additives for Petroleum Lubricants" is the title of a new 20-page educational booklet prepared by the American Cyanamid Company. It explains in non-technical language what additives are, why they are needed, when and where they are used, and how they improve lubricating oils. Numerous simple illustrations serve to assist the reader in understanding these complex subjects.

The booklet covers all the commonly used types of lubricating oil additives, and its novel approach to the additive subject should make it of equal interest to manufacturers, marketers, and users of additive-type lubricating oils.

(42) Drilling rig

Bulletin No. 350, 20 pages, describes and illustrates the Ideal Type 100 Consolidated Rig, which is designed for a maximum of 750 hp input (4400 ft-lb torque) and for drilling to a nominal depth of 10,000 ft with 4½-in. drill pipe; of 12,000 ft with 3½-in. drill pipe. Each unit of the rig is separately illustrated and described, including main frame, transmission, drumshaft, sand reel, catshaft, brakes, featured air-operated friction clutches, controls, drive groups, and other members. Engineering, operating and lubricating specifications are included, as well as a shaft speed diagram and dimensional drawing. The bulletin is released by The National Supply Company.

(43) Stainless piping systems

"Taylor Forge Stainless" provides a new and more economical approach to flanged piping, which the manufacturers report to have decided advantages. Four-page, illustrated Bulletin 483 includes drawings, dimensions and prices of new type fittings and flanges, available in Stainless 304, 347, 316 and other materials. The booklet is published by Taylor Forge & Pipe Works.

(44) Water strainer

A recently published folder (Catalog No. 37) describes the new Duplex Strainer now being manufactured by R-S Products Corporation, Philadelphia. This rugged, compact mechanism provides continuous clean water for industrial, processing, and utility purposes. Its unique feature is the incorporation of two basket strainer units within the main casing, arranged so that either can be cleaned while the other is functioning. The switch from one strainer to the other is accomplished by a single handwheel that operates a positive acting, non-fouling valve.

The booklet shows engineering drawings that indicate part dimensions for the six standard size strainers that range from 4 in. to 24 in. pipe-size service. Semi-log graphs show pressure loss and flow rates.

(45) Durimet 20

An 8-page bulletin has been issued on a high alloy low carbon austenitic stainless steel known as Durimet 20. Introduced just before the war, this alloy has proved to be markedly superior to standard 18-8 stainless steel analyses for certain severe corrosive services, especially in the handling of sulphuric acid, the manufacturer asserts. The Duriron Company, Inc., is the manufacturer.

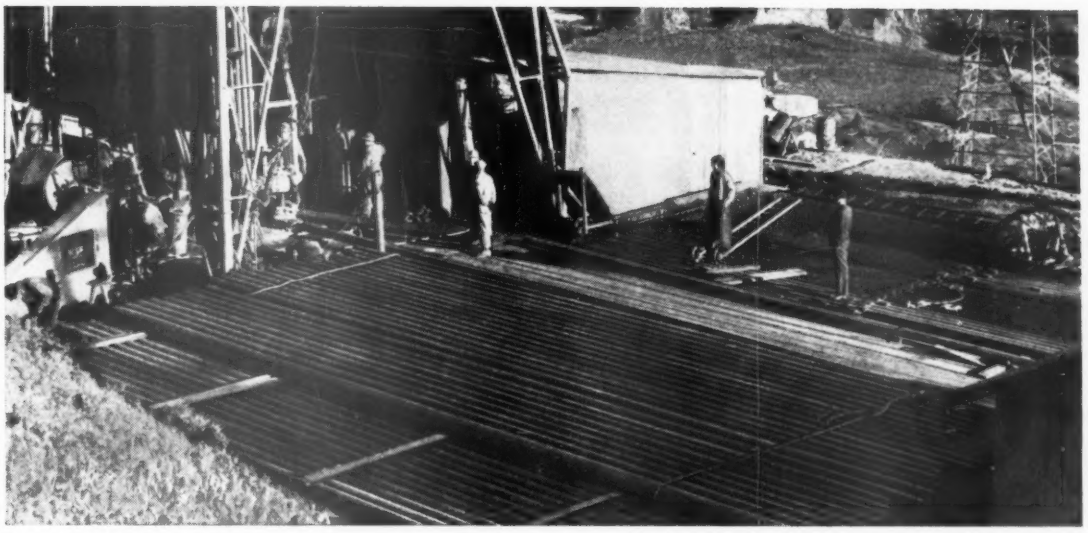
(46) Magna-Tector

Application of the Magna-Tector in locating stuck point of drill pipe, casing, or tubing is described and illustrated in a new 4-page, 2-color brochure. Benefits to the oil operator are explained and many new uses for the Magna-Tector are listed. Several interesting jobs performed by the Magna-Tector are described in detail. Published by McCullough Tool Company.

(47) 30-kc carrier system

Lenkurt Type 32 carrier systems are described in Folder CX39A. This 8-page publication describes the overall system, shows the relationship between maximum performance and minimum maintenance, and displays some of the facilities behind the design, development, and manufacture of Lenkurt equipment. Particular emphasis is placed on the filter engineering, which has opened up new spectrum space for use either as a narrow-band voice circuit or with a nine-channel f-m or a-m telegraph system specially designed for this application. It shows how, thus augmented, Lenkurt 32 carrier provides, in effect, a fourth channel.

DEPENDABILITY



In the Ventura (Cal.) field: 7400 feet of 7-inch SMITHway Casing.

THROUGH RESEARCH

In the A. O. Smith research laboratory: special collapse-testing apparatus for casing.

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running tour with men in the industry

● **K. E. Beall** has been elected to the office of vice president, economics department, Phillips Petroleum Company. Beall succeeds **J. M. Sands** who reached retirement age this year. Beall joined Phillips in 1920 as a production engineer. Upon the organization of the economics department he transferred to that department and since 1946 he has served as manager.

● **Frank A. Angona,** Dallas, physicist in the field research laboratories of Magnolia Petroleum Company, has been selected to receive one of the two graduate fellowships granted this year by the Socony-Vacuum Oil Company. Selected with Angona was **James Donnelly,** engineer in the Socony-Vacuum research and development laboratories, Paulsboro, New Jersey. The incentive fellowships are awarded annually to two members of the Socony-Vacuum and affiliated organizations on a competitive basis among all technical employes with a minimum of two years' service.

● **L. B. Snedden** has been promoted to assistant manager of the geophysical division, Producing Department, The Texas Company. Snedden, who will have headquarters in Houston, Texas, has been stationed at Bakersfield, California, where he was district geologist and supervisor of geophysical operations in California.

● **Thomas B. Malloy,** field engineer at Woodsboro, Texas, for Stanolind Oil and Gas Company, is now a petroleum engineer at the southwest Texas district office at Corpus Christi. **Robert C. Hagens,** petroleum engineer in the Woodsboro area, succeeds him as field engineer. **Robert O. Williams,** petroleum engineer at Corpus Christi, now holds a similar position in the Houston division office. **John W. Lord,** petroleum engineer in the Luby area, Robstown, Texas, is the new field engineer in the Luby area.

● **George W. Hall** of the Weatherford Spring Company, Weatherford, Texas, recently returned from a four months' trip to the oil fields of Iran, Iraq, Kuwait, and Saudi-Arabia, inspecting Weatherford Spring oil well cementing installations at these points. Leaving Weatherford on January 6, he flew to London, thence to Kuwait on the Persian Gulf. From Kuwait, he made inspection tours of oil fields at Masjid i Sulaiman, White Oil Springs, Haft Kel, Lali, Ahwaz, Agha Jari, and the refinery at Abadan, all in Iran. Later he inspected the fields at Dhahran of Saudi Arabia, and Bahrein Island in the Persian Gulf. The proximity of the Kuwait fields to the USSR prompted Hall to inquire into the relationship between the natives and the Russians. Those questioned answered briefly and pointedly: "Moszane", which is roughly translated "No good!"

● **Robert W. Eiler,** secretary and general attorney of The National Supply Company, has been elected a director of the company. A graduate of Cornell University law school, he practiced law in Chicago and Pittsburgh. He became general attorney for National Supply in 1937 and was elected secretary of the company two years later. He is also secretary and director of the National Supply Export Corporation, National Supply Company, Ltd., and National Supply Construction Corporation, and is a director of Fretz-Moon Tube Company, of Butler, Pennsylvania. He replaces **Charles R. Barton** retired, on National Supply's board of directors.

● **C. G. Kirkbride,** director of laboratories for Houdry Process Corporation, Philadelphia, Pennsylvania, has been elected vice president in charge of research and development. Kirkbride, a director of the company, has served as laboratories chief since April, 1947. Author of the textbook, "Chemical Engineering Fundamentals," Kirkbride joined Houdry after serving as professor of chemical engineering at the Agricultural and Mechanical College of Texas.

He has had broad experience in the petroleum field, having served as chief of chemical engineering development for the Magnolia Petroleum Company at its Dallas laboratories; assistant director of research for Pan-American Refining Company, and chemical engineer in the Whiting Laboratories of Standard Oil Company of Indiana.

Prominent in oil circles, Kirkbride is a director of the American Institute of Chemical Engineers and is also secretary-treasurer of the Petroleum Chemistry Division, American Chemical Society.

● **Floyd H. Boyer,** Temple Court Building, 628 15th Street, Denver Colorado, has been appointed sales representative for the State of Colorado and Laramie County, Wyoming, by Ampco Metal, Inc., Milwaukee, Wisconsin. Boyer will handle the sale of all Ampco products with the exception of arc and resistance welding electrodes and centrifugal pumps.

● **W. P. Anderson** has been appointed general manager of refineries for Caltex in the East of Suez and Eastern Mediterranean territories. After taking a B. S. degree in chemical engineering from the University of California, Anderson, in 1925, entered the research and development department of the Richmond Refinery of Standard Oil Company of California. After some years in this department, and as foreman of the cracking unit department, in 1936 he went to Bahrein Island in the Persian Gulf as superintendent of the Caltex refinery then being built. Anderson became general manager at Bahrein in 1942 and continued until 1946 when he was transferred to the New York offices of Caltex.

● **Dr. Theodore A. Link** has resigned from his position as chief geologist for Imperial Oil Limited, with which company he has been associated for 29 years, and will engage in consulting practice. He will announce his business address in Toronto, Ontario, and Calgary, Alberta, as soon as established. In the meantime he may be reached at his home address, No. 7 Grenadier Heights, Toronto 3, Ontario, Canada.

● **Frank A. Bohen,** division engineer, refinery and pipe line equipment sales, for Oil Well Supply Company's eastern division, has had his headquarters moved to the division sales office in Chicago, according to an announcement at this U. S. Steel subsidiary's main offices in Dallas, Texas. Bohen has been at the eastern division headquarters in Columbus, Ohio.

● **J. B. Christian** has been promoted to assistant general manager of Trinidad Leaseholds Limited, Trinidad, B. W. I. **H. W. MacNaughton-Jones** has been appointed manager, refinery division, of the same company.

● **Denver R. Williams,** assistant to the manager of the crude oil purchase and sales department of the Ohio Oil Company, has been appointed manager of that department. A native of Findlay, Williams was employed by The Ohio Oil Company immediately after his graduation from Findlay High School in June, 1926. Following three months as a messenger, he was transferred to the transportation department, where he became a stenographer and chief clerk. Later assignments were in the Ohio production division and the president's office. In December, 1932, he was transferred to the crude oil purchase and sales department and in March, 1945, was made assistant to the manager.

● **Simon J. Vos,** manager of Regent Oil Company, Ltd., and acting managing director of Trinidad Leaseholds Limited, both of London, has been appointed a director of Central Mining and Investment Corporation of London.

● **T. C. Borland,** formerly assistant division engineer of the Texas-Louisiana Gulf Coast division of Stanolind Oil and Gas Company, has been promoted to division engineer at Houston, Texas.

● **John S. Boldrick,** formerly division petroleum engineer, has been appointed division superintendent of Humble Oil and Refining Company's Louisiana division office at New Orleans.

To fill Boldrick's previous position the company named **J. C. Posgate,** former assistant division petroleum engineer in New Orleans.

The new assistant petroleum engineer is **H. M. Krause, Jr.** Krause was promoted to the Louisiana division from Humble's home office in Houston, where he was supervising petroleum engineer in the petroleum engineering division.

10 GOOD REASONS WHY OPERATORS PREFER

McCullough
GUN PERFORATOR SERVICE

1. **MEETS EVERY CONDITION.** Guns fired either electrically or mechanically: guns run on cable, sand line, drill pipe, tubing, or on piano-wire measuring line in extremely high-pressure wells.
2. **SIMULTANEOUS FIRING** under all conditions gives exact spacing of shots, perfect perforation pattern, and saves down-the-hole time.
3. **ACCURATE DEPTH MEASUREMENTS** put the shots right where you order them.
4. **MAXIMUM PENETRATION** of bullets into the formation, as proved repeatedly in competitive field tests.
5. **GUNS TO FIT EVERY CONDITION.** McCullough employs more than 30 different types and sizes of guns.
6. **ALL SIZES OF BULLETS** from $\frac{1}{8}$" dia. up to $\frac{3}{4}$" dia., to fit every possible need.
7. **BURRLESS BULLETS,** giving a completely burr-free hole, eliminating casing scraping, with *no* sacrifice of penetration.
8. **NO LOST TIME.** McCullough's simpler, lighter equipment cuts setting-up and moving-out time, speeds up every job.
9. **EXPERIENCED MEN.** With years of experience behind them, thoroughly-trained McCullough gun-perforating crews do their jobs quickly, efficiently, safely.

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PUTS THE SHOTS WHERE THEY [illegible]UNT!

10 This is a section of a McCullough 90-SHOT GUN perforating a 15-foot section with 6 holes to the foot, at one run.
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KANSAS: Ulysses
CALIFORNIA: Los Angeles, Avenal, Bakersfield, Ventura
MONTANA: Cut Bank
LOUISIANA: Houma, Lake Charles, New Iberia, Shreveport
WYOMING: Casper

EXPORT OFFICE: 30 Rockefeller Plaza, New York 20, N. Y.

● **H. Wayne Hoylman,** for the last 18 years a member of the geophysic staff of the Gulf Research and Development Company, and who, as a specialist in magnetics, has been closely connected with the development of airborne magnetic interpretation technics, recently joined Fairchild Aerial Surveys, Inc., as chief geophysicist. His new address is Airborne Magnetometer Division, Fairchild Aerial Surveys, Inc., 224 East Eleventh Street, Los Angeles 15, California.

● **E. L. Hinds,** core drill supervisor with a Florida exploration party, has been named division core drill supervisor at Fort Worth, Texas, by Stanolind Oil and Gas Company.

● **G. A. Isaacks** has been appointed to the new post of assistant division drilling superintendent at Houston, of the Texas-Louisiana Gulf Coast division of Stanolind Oil and Gas Company. He was formerly district superintendent at Beaumont, Texas. **C. W. Black,** field superintendent for the Luby area at Robstown, Texas, is the new Beaumont district superintendent. **T. E. Keefer,** superintendent of the Hastings field at Alvin, Texas, is now field superintendent of the Luby area. **D. R. Blocker,** field superintendent at South Houston, has been transferred to the Hastings post. **H. H. Wagner,** field superintendent of the Turtle Bay area, Liberty, Texas, is the new South Houston field superintendent. **W. T. Moore,** formerly district engineer at Lake Charles, Louisiana, is the new Turtle Bay field superintendent. **F. L. Nelson,** petroleum engineer in the Lake Charles office is new district engineer.

● **J. B. Lawson** has been appointed general superintendent of operations of Great Lakes Pipe Line Company to succeed **E. H. Skinner,** vice president for operations and general superintendent, resigned. Lawson has been assistant general superintendent.

The new superintendent, whose entire working experience has been in the pipe line industry, has been with Great Lakes since it was organized, serving during its formative period in 1930-31 as an inspector of construction. When the system was placed in operation Lawson aided in establishing operating methods at pump stations and terminals, and then served in succession as a district, division, and field superintendent until being named assistant general superintendent January 1, 1947.

● **B. A. Cunningham, Jr.,** a petroleum engineer in the Republic Bank oil department since 1936, was elected vice president of the Republic National Bank, Dallas, at a recent meeting of the board of directors, according to announcement by Fred F. Florence, president. A graduate of Cornell University, Cunningham is a member of the American Institute of Mining Metallurgical Engineers and the American Association of Petroleum Geologists. Florence also announced the election of **J. Howard Ferguson,** president of the United States National Bank, Denver, Colorado, as vice president of the Republic National Bank to assume duties on September 1.

● **J. L. Nichols** has been named to the new post of drilling superintendent of the North Texas-New Mexico division of Stanolind Oil and Gas Company, and will have his headquarters at Fort Worth. He was formerly district superintendent at Greggton, Texas. **F. A. Schell, Jr.,** succeeds Nichols. He was formerly East Texas field superintendent. **Ralph Ludwick,** a production foreman in the East Texas area becomes field superintendent. **R. C. Peeler,** production foreman at Brownfield, Texas, has been named assistant field superintendent of the East Texas area. **L. W. Reynolds,** former assistant field superintendent in the East Texas operations, has been named field superintendent at Andrews, Texas. **J. B. Jenkins** has been named assistant division engineer at Fort Worth, succeeding **C. J. Christensen,** new district superintendent at Shreveport, Louisiana. Jenkins had been district engineer at Lubbock, Texas. New Lubbock district engineer is **G. E. Crosby,** formerly field engineer for the Hendrick area at Wink, Texas. **E. M. Knight,** petroleum engineer in the Fort Worth division office, has been named Hendrick field engineer.

● **Glen H. Bowes,** has resigned as assistant region geologist of Continental Oil Company at Los Angeles, California, and accepted a position as manager of the exploration department of the Hudson's Bay Oil and Gas Company, Ltd. Hudson's Bay Oil and Gas Company, Ltd., an affiliate of Continental, maintains headquarters at Calgary and Winnipeg, Canada, and has extensive holdings in the Turner Valley, Leduc, Lloydminster, and Viking-Kinsella fields of Canada, as well as large areas of unexplored acreage upon which it is conducting a vigorous exploratory campaign.

Born in Monrovia, California, Bowes received his A.B. degree in petroleum geology at Leland Stanford University, and did graduate work at the same school. He has been with Continental for the last 25 years, serving as geologist and assistant region geologist at Los Angeles.

● **Roy J. Diwoky** has been promoted to assistant general superintendent of the Whiting, Indiana, refinery of Standard Oil Company (Indiana). Diwoky joined the company in 1935 as a member of the technical service staff of the research department at the Whiting laboratory where he became a group leader in 1939. In 1940 he was transferred to the manufacturing department at the Whiting refinery as assistant general foreman of pressure stills in the light oils division. After becoming technical assistant to the executive manufacturing staff in the general office at Chicago in 1943 and assistant superintendent of the light oils division at Whiting in 1945, he was appointed superintendent of the Whiting projects division in 1947.

● **Alvin R. Summers,** formerly north and west Oklahoma production division superintendent at Oklahoma City, for Sunray Oil Corporation, has been named Oklahoma division superintendent and will also be in charge of Sunray's south and central Oklahoma production department operations in the greater Seminole area. Summers will continue to make his headquarters at Oklahoma City.

C. C. Shreve, formerly the company's Oklahoma division superintendent for the greater Seminole area, Allen, Oklahoma, has been transferred to Great Bend, Kansas, where he will be Kansas division superintendent for Sunray. In this capacity, he succeeds F. D. Sabourin, resigned.

V. L. (Fred) Smith, division engineer at Allen, will take on increased duties as production superintendent in the greater Seminole area.

Lee Pruitt, formerly district engineer of northern and western Oklahoma division, Oklahoma City, has been transferred to Odessa, Texas, as district engineer, north and west Texas division. He succeeds A. W. Paine, resigned.

Fred McDaniel, division engineer, Great Bend, Kansas, has been named assistant division superintendent for the Kansas division, and **Dudley Strother,** formerly engineer at Oklahoma City, has been transferred to Great Bend as an engineer.

Two new Sunray employees in the production department are **W. L. Gaither,** district engineer, Seminole, Oklahoma, and **Glenn Marrs,** engineer at Oklahoma City.

● **O. F. Ellzey** of New Orleans, who has been with The Texas Company 22 years, has been appointed general superintendent of the Oklahoma Division, producing department, of the company. Ellzey, who now has headquarters in Tulsa, formerly was in New Orleans.

● **W. O. Bagley, Jr.,** has been named manager of the Ellinwood, Kansas, store of the Continental Supply Company, Dallas. Bagley has been serving at the same point as field manager. He succeeds **A. M. Rouse** who resigned.

● **M. M. Montgomery** has been promoted to assistant operating superintendent in charge of producing operations for Stanolind Oil and Gas Company. Montgomery, who has been executive assistant to J. E. Rouse, vice president in charge of operations, will be replaced by **Lewis Finch, Jr.,** formerly West Texas district superintendent at Midland. Both men will work in the company's Tulsa general office. **T. B. Campbell,** who has been division engineer at Houston, succeeds Finch.

● **Bernard R. Carney** has been appointed manager of the gas division of Warren Petroleum Corporation, Tulsa, Oklahoma. Carney, who will now make his headquarters in Tulsa, was formerly assistant to the president of Shamrock Oil and Gas Company in Amarillo, Texas.

● **Thomas G. Gleason** has been added to the New York office staff of the Peabody Engineering Corporation. A graduate engineer of Columbia University (chemical engineering) Gleason will be engaged in studying special applications and in product development work of the scrubber division.

FIG. 1. Radical new experimental Boeing XB-47 jet bomber has sleek lines and sharply swept-back wings and tail surfaces. The ultra-thin wings support six General Electric jet engines in double nacelles inboard and singly near the swept back wing tips. Wing span is approximately 116 ft and length is 108 ft. Unusual landing gear is of the tandem type. The main wheels retract into fore and aft sections of the body, while small outrigger wheels under each inboard power nacelle provide lateral stability in ground operations.

Jet fuels for aircraft*

By H. A. MURRAY, Technical and Research Division, The Texas Company

● **Introduction.** This paper will attempt to cover the present and future fuel requirements of the aircraft gas turbine type of power plant. So far as the fuel requirements are concerned the turbine or "turbo engine" is the same either as a jet engine or a turbo propeller type of propulsion. This paper will not attempt to cover the fuel requirements of ram jets, pulse jets, or rocket forms of propulsion that are under military restrictions at the present time.

The adoption of the turbo engine in a majority of new or experimental models of aircraft instead of the piston engine is bound to affect the type of fuel that the petroleum industry will be called upon to supply in the near future. Although the information on this subject is far from being complete at this time, there are, nevertheless, enough data to provide us with some of the general characteristics of jet fuels. This paper will cover some of the important physical properties such as volatility, fuel composition, stability, freezing point, and heating value. Discussions on fire hazard and availability also are included. Differences between the anticipated characteristics of jet fuels for military and commercial service also are summarized.

The sources of this information came from contacts with the aircraft industry (principally engine builders), airlines, work conducted by The Texas Company's laboratories at Beacon, New York, and Port Arthur, Texas, and several principal refineries. Some material came from two excellent papers presented this year—the first by C. G. Williams of Shell Refining and Marketing Company, Ltd., England (Joint meeting of Institute of Petroleum and Royal Aeronautical Society, February, 1947) and the second paper by C. R. Johnson of Shell Oil Company (American Society of Mechanical Engineers, Los Angeles, California, May 28, 1947).

● **Volatility.** Volatility is one of the most important physical properties of jet fuels. It is important because of its effect upon starting, combustion efficiency, engine deposits, evaporation losses, vapor locking, fire hazard, and even availability.

High rates of climb and high altitude operation may be responsible for some appreciable losses of fuel from evaporation. A comparison between evaporation losses of aviation gasoline and a low volatility fuel is shown on Fig. 2. Starting with a fuel temperature of 100 F in a tank at the time of take-off, it is apparent that appreciable losses may occur with aviation gasoline upon reaching altitudes in excess of 20,000 ft, whereas the losses from a less volatile fuel are insignificant up to 55,000 ft.

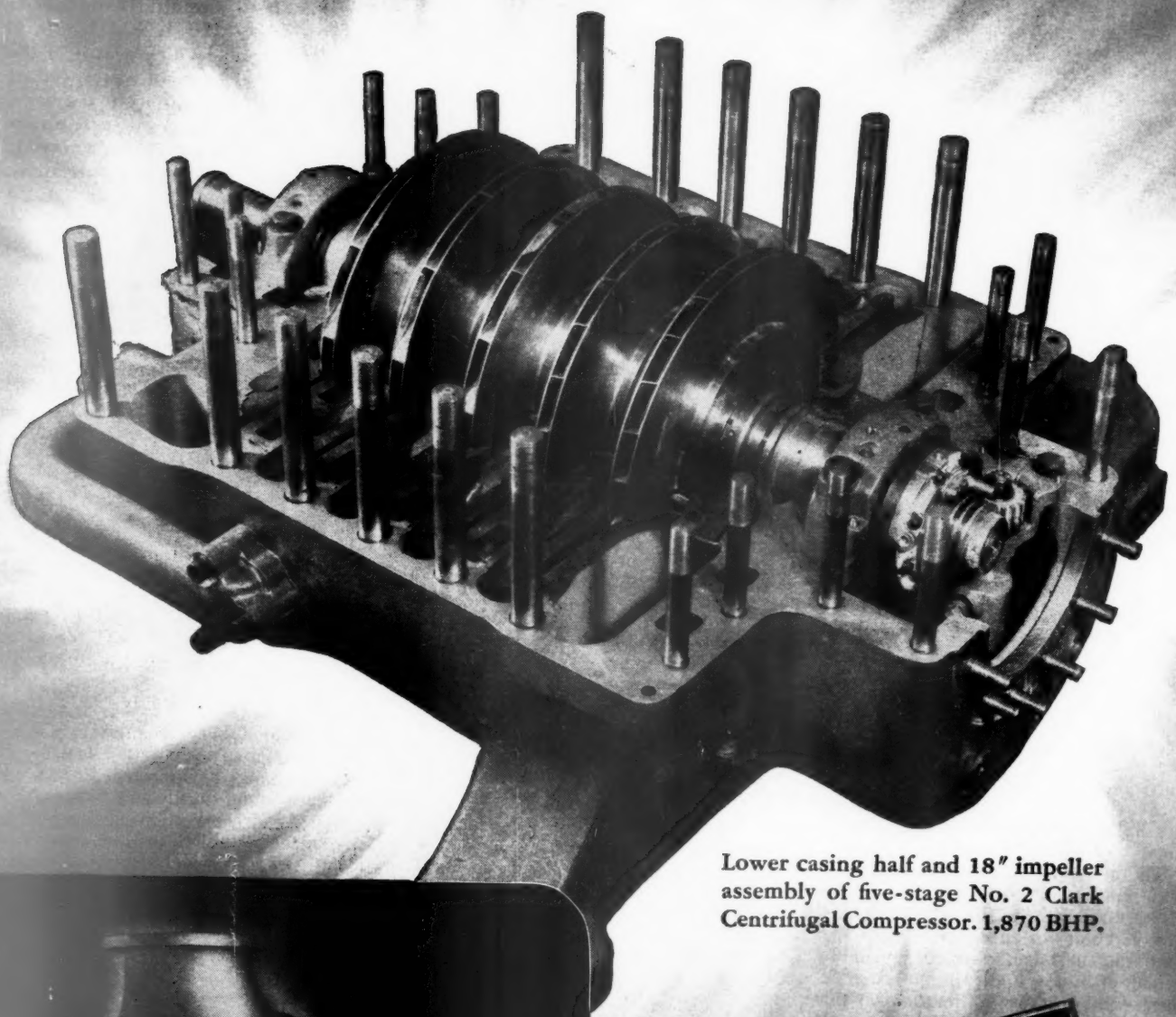
Vapor locking tendencies of aviation gasoline at various altitudes are compared with those of low volatility fuel (Fig. 3). Aviation gasoline will require fuel booster pumps to prevent vapor locking, whereas these pumps have not been found necessary when using a low volatility fuel. If a fuel system has a vapor-liquid volume ratio of 2 and a fuel temperature of 100 F, it is apparent that with aviation gasoline booster pumps will have to be operated before reaching an altitude of 15,000 ft to prevent vapor locking, whereas the same system would not require booster pumps up to 55,000 ft with a low volatility fuel.

Although a volatile fuel such as aviation gasoline has some disadvantages with respect to evaporation losses and vapor locking, it has some distinct advantages found during low temperature starting and combustion efficiency. The tolerance permitted in the front end volatility varies widely from one engine to another and no general conclusions can be reached at this time; however, a certain amount of general information is available on a few of the more popular designs of jet engines that may be of interest. Aviation gasoline with an ASTM distillation 10 per cent point of 160 F permits easy starting at temperatures down to minus 65 F. In the same type engine, starting may be difficult at temperatures around minus 40 F with a fuel having a 10 per cent point of 300 to 380 F.

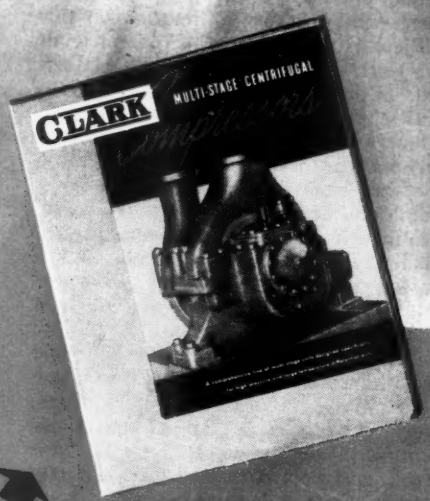
During the starting period of a turbo engine richer mixtures are employed, a procedure that is similar to the piston engine. If the start of combustion is delayed, as it might be with a low volatility type of fuel, the whole interior of the turbine engine may become drenched with unburned fuel that is apt to burn off suddenly once combustion has begun causing overheating or a "hot start." Although "hot starts" can be reduced through changes in engine design and starting technique, they, nevertheless, depend upon fuel volatility. Hot starts

*Presented before Texas Mid-Continent Oil and Gas Association 28th Annual Meeting, San Antonio, Texas, October 17, 1947.

CLARK CENTRIFUGAL C



Lower casing half and 18″ impeller assembly of five-stage No. 2 Clark Centrifugal Compressor. 1,870 BHP.



Write for Bulletin on Centrifugal Compressors

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SETS THE PACE IN COMPRESSOR PROGRESS

are bad for the engine because of overheating and subsequent damage to engine parts.

Although some of the leading models of jet engines have been designed for satisfactory operation on either a low volatility fuel such as kerosine or even gasoline, a few brief tests were conducted with heavier fuels to find out what might happen in regard to starting, combustion efficiency, and deposits. The tests with the heavier fuels, Nos. 64, 65, 66, and 67 (Fig. 4), were run on one model of full scale jet engine. The tests on this one engine are somewhat limited and not to be construed as applicable to other models of jet engines. With gas oil No. 64 (B.P. 464-688 F) starting was impossible at room temperature, although the engine would operate fairly well under cruising conditions at sea level if started on kerosine and switched over to this fuel. Combustion was poor under both idling conditions and rated speeds. With a heavier gas oil, No. 65 (B.P. 475-724 F +) starting was impossible and the engine would not operate under any conditions. The next heavy fuel tested was a gas oil-distillate blend, No. 66, having a much lower front end (B.P. 362-715 F) and this fuel started satisfactorily at room temperatures and permitted normal operation in the cruising range, although performance of the engine was not very good at idling and rated speeds. The heaviest fuel tested was a topped crude, No. 67, (B.P. 405-750 F +). It was necessary to start the engine with kerosine and then switch over to this fuel and poor operation was observed throughout the entire speed range under sea level conditions. The burning characteristics of this fuel were so slow that the flame extended down through the turbine disk and into the tail cone assembly causing overheating and damage to these parts. Although this particular engine was designed to utilize kerosine, it is interesting to note what may be expected with some of the heavier gas oils.

● **Fire hazard.** Commercial operators believe that that turbo engine has advantages over the piston engine in its ability to use a less volatile fuel and thereby reduce some of the fire hazards. It should be pointed out that any fuel that will burn in an engine will also burn outside under the right set of conditions, and since no fuel can be regarded as absolutely fireproof, the term safety fuel is a misnomer. At the same time there appears to be some important differences between the inflammability of different fuels under certain conditions, which will be discussed below.

The three types of fire hazards involving aviation fuels are as follows:

A. Explosion hazard of the vapors in the fuel tank.

B. Spontaneous ignition from contact with a hot surface.

C. Fires arising from spilled or crashed fuel covering the airplane or the ground.

A comparison between the explosive limits of aviation gasoline and low volatility fuel appear on Fig. 5. These data were obtained from tests at our Beacon laboratory using a hot wire as an ignition source in the vapor space. The solid line in these curves indicates the lean limit and the broken line, which only partly completes the envelope, the rich limit of explosion. From these data, it appears that explosive conditions in the vapor space may be found with a low volatility fuel under extremely hot weather conditions and also with aviation gasoline under extremely low temperature conditions. Considering the wide variety of temperatures and altitudes under which aircraft operate today, the relative explosion hazards of both fuels are approximately the same. The use of an inert gas such as CO_2 or nitrogen has been proposed for the purpose of blanketing fuels if it is found necessary to prevent an explosive mixture from forming.

Similar tests in the same laboratory provide some interesting information on other types of fire (B and C). The test equipment (Fig. 6) consisted of a fire stage with a concrete platform 6 ft by 24 ft, a 9-ft backwall, and a large blower at one end to provide winds up to 15 mph. More than a thousand tests have been conducted to date utilizing fuels and oils of widely different distillation ranges and compositions. These fuels and oils were crashed in bottles or spilled from containers from different heights. The sources of ignition employed were hot pipe, hot wire, spark and flare, and atmospheric conditions included all sorts of winter and summer weather.

Results of a few samples that were crashed on hot pipe or manifold showed the following results:

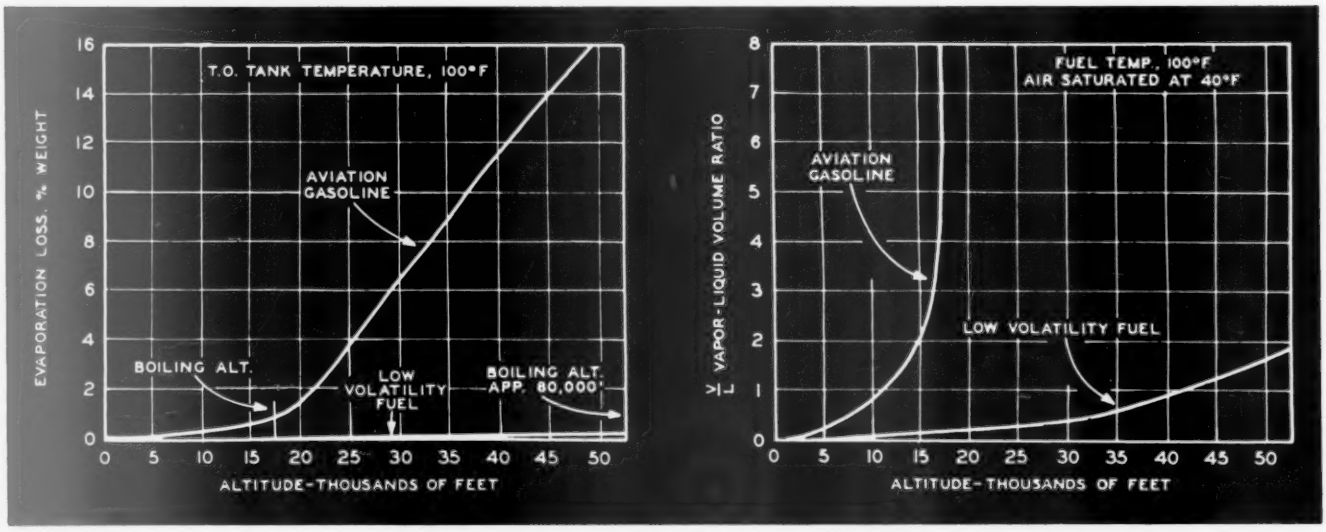
	Minimum spontaneous ignition temp., F
Aviation gasoline 100/130	1100
Low volatility fuel (300-400 F)	1050
Aircraft engine oil 120	750

Although heavy lubricating oil had a lower spontaneous ignition temperature than the gasoline samples, the latter burned more violently if the surface temperature was high enough to ignite both types. These demonstrations showed that oil fires were confined to local areas and spread very slowly, if at all. With gasoline, however, the spread of fire was almost instantaneous wherever the spray or vapors happened to go.

The effect of volatility on inflammability is illustrated in Fig. 7. This figure shows the borderline condition between a fire and no fire regions under various sources of ignition, wind velocities, and methods of crashing or spilling samples. The worst condition found was spilling fuel from a 2 ft height into a lighted flare in the presence of a 15 mph wind. Under these conditions the borderline volatility betwen a fire and no fire regions was an ASTM 10 per cent distillation point minus an atmospheric temperature of 250 F. In other words, at

FIG. 2. (Reference 'A'). Comparison of evaporation losses from aircraft fuel tanks when using current aviation gasoline and low volatility fuel.

FIG. 3. (Reference 'A'). Comparison of vapor formation in aircraft fuel system when using current aviation gasoline and low volatility fuel.



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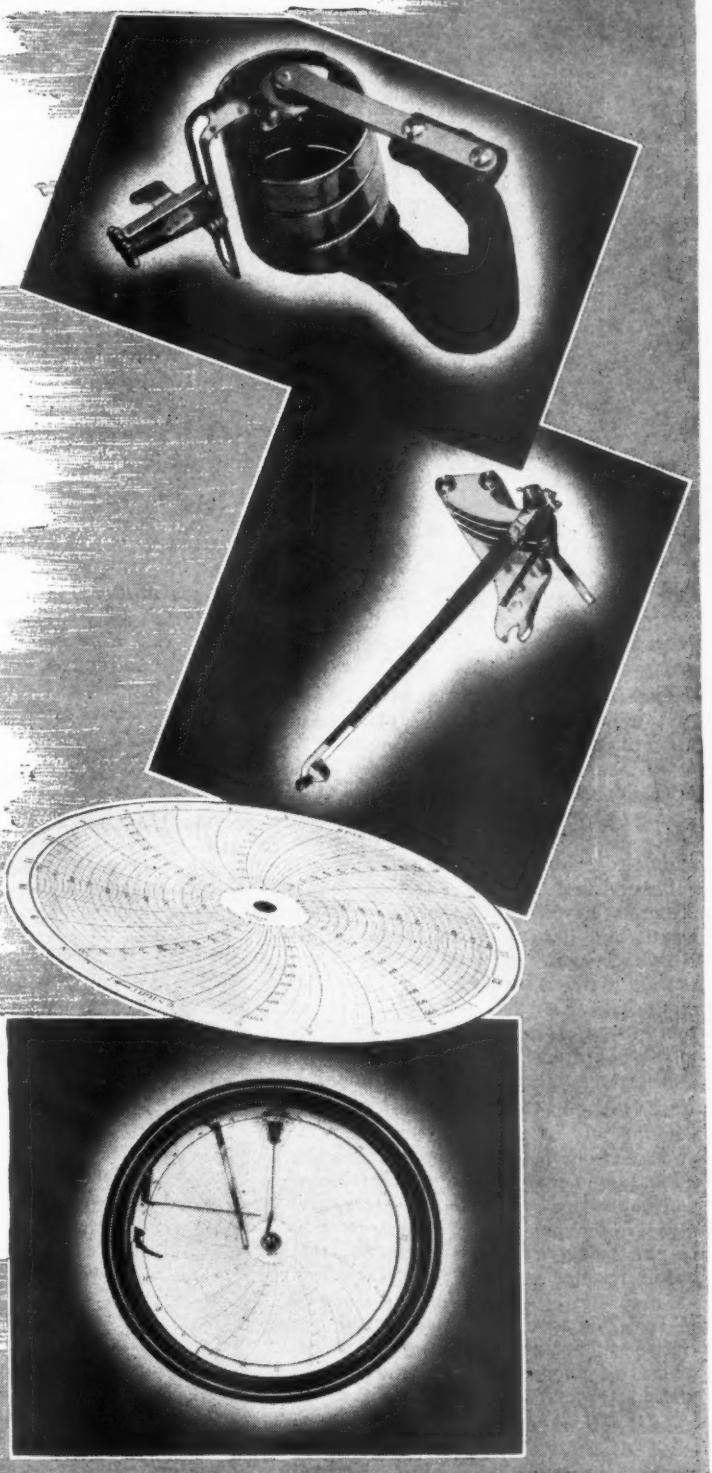

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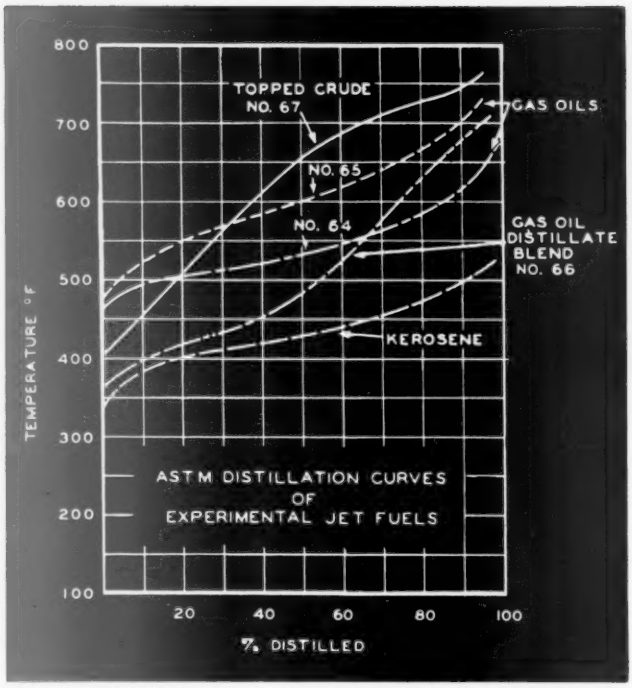

FIG. 4. ASTM distillation curves of experimental jet fuels.

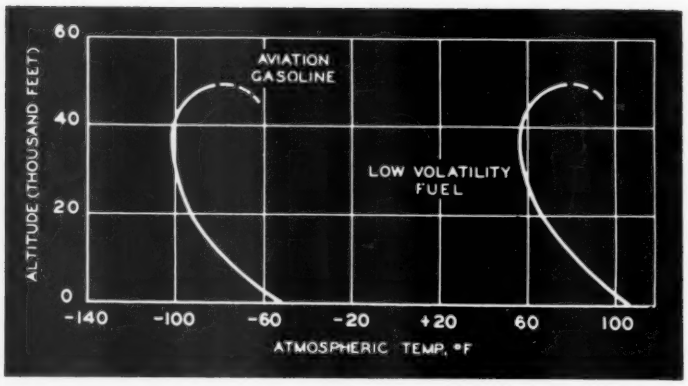

FIG. 5. Explosive limits of aviation fuels. (Curves apply to equilibrium conditions.)

100 F atmospheric temperature a fuel having a 10 per cent point of 350 F would be borderline with respect to inflammability under these conditions.

It should be brought out at this time that there is no concrete data, based upon experience, of relative fire hazards of various fuels in aircraft. There is no operational experience available of a number of identical aircraft where part of the group used a volatile fuel such as aviation gasoline and the other a low volatility fuel such as kerosine. Some attempts have been made to compare relative fire hazards of one model of aircraft using gasoline with another model of an entirely different design and engine using a low volatility type of fuel; however, it is impossible to draw any conclusions from these examples due to the number of variables involved.

● **Composition.** From the limited amount of information available, it appears that fuel composition has some effect upon combustion efficiency, smoke, and deposits. Some of the more popular models of jet engines do not appear to be particularly sensitive in this respect; however, since engine design plays such an important part on the performance of fuels, data obtained in one model of engine do not necessarily apply to another and, therefore, it is impossible to make any general conclusions now.

In two well-known models of jet engines, both paraffinic and naphthenic straight run fuels were easier to burn than a highly aromatic type made from cracked stocks. For example, of three fuels with identical distillation range, similar to kerosine, but of different composition, paraffinic and naphthenic fuels showed good combustion efficiency and freedom from smoke or deposits at various altitudes up to 40,000 ft. The aromatic fuel, containing approximately 50 per cent aromatics, was more difficult to burn and gave some smoking and rather objectionable deposits under sea level conditions after a short period of testing.

The general feeling is that fuels containing aromatics up to 30 per cent may be satisfactory although much more data are necessary before any general conclusions can be reached. A great deal of information is needed from studying the behavior of aromatic fuels of different distillation ranges. The behavior of olefins also must be carefully investigated before we will know whether cracked fuels may be successfully used in the turbo engine.

● **Heating value.** The principal disadvantage of the turbo engine compared with the piston engine is its higher fuel consumption. As heating value of the fuel directly affects the range of aircraft, it is desirable to select a fuel of the highest heating value. As the latest models of aircraft are becoming volume limited, i.e., less space is available for fuel tanks as a result of thinner wings, higher wing loading, and smaller fuselage, it appears that selecting a fuel of the highest Btu per gal is desirable.

A comparison between Btu per gal of aviation gasoline and three heavier fuels

FIG. 6. "Fire test stage."

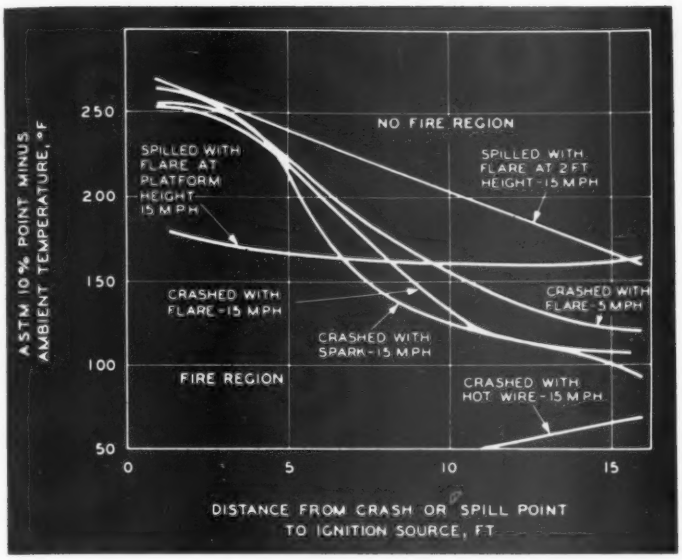

FIG. 7. Borderline volatility for various types of tests and ignition sources.

in the kerosine distillation range is given below:

	Btu/gal	Per cent increase compared aviation gasoline
Aviation gasoline 100/130	114,000	
Kerosine distillation range		
Paraffinic	126,700	11
Naphthenic	130,000	14
Aromatic	134,000	17.5

It is apparent that fuels of higher boiling point have greater heating values per gallon than aviation gasoline and also that aromatic type of fuels have greater heating value per gallon than either paraffinic or naphthenic fuels. Actual service tests between kerosine and aviation gasoline in a certain jet powered aircraft have demonstrated that improvement in range is almost in direct proportion to the heating value. On the basis of increasing the range of aircraft, it might be advisable to have engines designed to utilize aromatic type of fuels with higher boiling points if possible.

● **Stability.** Some preliminary gum studies indicate that the proposed methods of gum tests are not too well suited to fuels with boiling points up to 600 F maximum. Not only does it appear that different methods may be necessary but a different set of permissible gum values may be desirable as well. The proposed methods of gum tests in their present form may exclude the use of any appreciable quantity of cracked stocks and thereby restrict the amount of jet fuels that can be made available. In Table 1 is given a resume of some of these gum studies showing a comparison between proposed JP-3 grade fuels made from straight run stocks and straight run cracked blends. Five straight run fuels, Nos. 73, 74, 84, 85 and 86 (Table 1) were prepared from a wide variety of crude sources. With one exception these fuels met the proposed residue and accelerated gum tests indicating that such fuels do not present much of a problem in this respect.

Three blends of cracked fuels, Nos. 75, 76, and 77 (Table 1) showed very high residue and accelerated gum values. Even if such fuels were inhibited for satisfactory storage, it is doubtful whether they would pass the proposed gum tests. Long-time storage tests with cracked fuels are necessary to establish whether they are satisfactory from the standpoint of stability.

● **Freezing point.** Low temperature characteristics of jet fuels are particularly important in military service. The freezing point of minus 76 F maximum in the present JP-1 grade of jet fuel and the proposed JP-3 grade (Table 2) was obviously inherited from former aviation gasoline specifications. Comparatively little information is available indicating the maximum allowable freezing point based on actual test data of aircraft fuel systems, and this is believed necessary before any conclusions can be reached. A study is now beginning on the effect of freezing point and cloud point on the pumpability of such fuels in aircraft fuel systems being tested in the cold room.

In addition to freezing point and cloud point of fuels, there is also a third factor, formation of ice crystals, which affects the low temperature behavior of fuels. At certain temperatures fuels may contain up to 0.015 per cent by weight of water dissolved in the fuel. As the fuel temperature is reduced, its water solubility is also reduced, producing or causing the precipitation of traces of water and finally the formation of ice crystals. Some investigations in England reported clogging of fuel filters from ice crystals at extremely low temperatures from this cause. These data also show approximately the same degree of water solubility of aviation gasoline and kerosine. This situation has not been recognized as a serious problem in American aircraft and the relative freedom from this source of trouble may be attributed to different types of fuel filters. In military operation the low freezing point of jet fuel is believed desirable, although in commercial service some compromise may be made in the interest of reduction of fire hazard and fuel cost.

● **Availability.** The ultimate estimated requirements of jet fuels for military service will be several times greater than for aviation gasoline. An industry-wide study has been underway to determine

TABLE 1. Gum study of various straight run and cracked fuels for proposed JP-3 specification.

	Proposed JP-3	100 per cent straight run — Fuel numbers					Cracked—straight run blends — Fuel numbers		
		73	74	84	85	86	75	76	77
Air jet residue, AN-F-34	5.0	4, 4	3, 3	4	3	15	17, 20	50	51
Accel. gum AN-F-34 (7 hr)	...	3, 3	4, 3	..	11	18	125	..	140
Accel. gum AN-F-34 (16 hr)	8.0	3, 5	8	2	7	22	851	97	360
Distillation, ASTM, temp. °F EP	500–600	565	550	566	583	587	554	570	600

TABLE 2. Detailed requirements of existing and proposed Army-Navy aeronautical jet fuel specifications.

Tests	JP-1 AN-F-32	JP-2 AN-F-34	JP-3 Proposed
Gravity, °API	...	35.0 min.	...
Specific gravity at 60° F	0.850 max.	...	...
Flash, Tag, closed, °F	100 min.	...	...
Viscosity, Kinematic at 100° F	...	0.95 min.	...
Viscosity, Kinematic at −40° F	10.0 max.	10.0 max.	10.0 max.
Color, Saybolt	+12 min.	+12 min.	...
Corrosion, cu strip at 212° F	Slight max.	Slight max.	Pass
Sulfur, per cent	0.20 max.	0.20 max.	0.5 max.
Residue, air jet, mg/100 ml	5 max.	5 max.	10 max.
Gum accelerated, mg*	8 max.	8 max.	20 max.
Bromine number	3.0 max.	3.0 max.	14 max.
Reid vapor pressure	...	2.0 max.	5–7
Aromatics, volume per cent	20 max.	20 max.	30 max.
Freezing point, °F	−76 max.	−76 max.	−76 max.
Water tolerance	Sub. im.	Sub. im.	Sub. im.†
Heat of combustion, lower valve, Btu/lb	...	...	18,200 min.
Distillation, temp. °F.			
IBP	...	150 min.	...
10 per cent	410 max. evap.	...	...
90 per cent	490 max. evap.	...	425 min.
EP	572 max.	500 max.	600 max.
Per cent residue	1.5 max.	1.5 max.	1.5 max.
Per cent loss	1.5 max.	1.5 max.	...
Inhibitor content, lb/5000 gal‡	...	...	1.0 max.

*Method of AN-F-32, Amend. 3.
†Substantially immiscible.
‡Approved inhibitors same as those in AN-F-48.

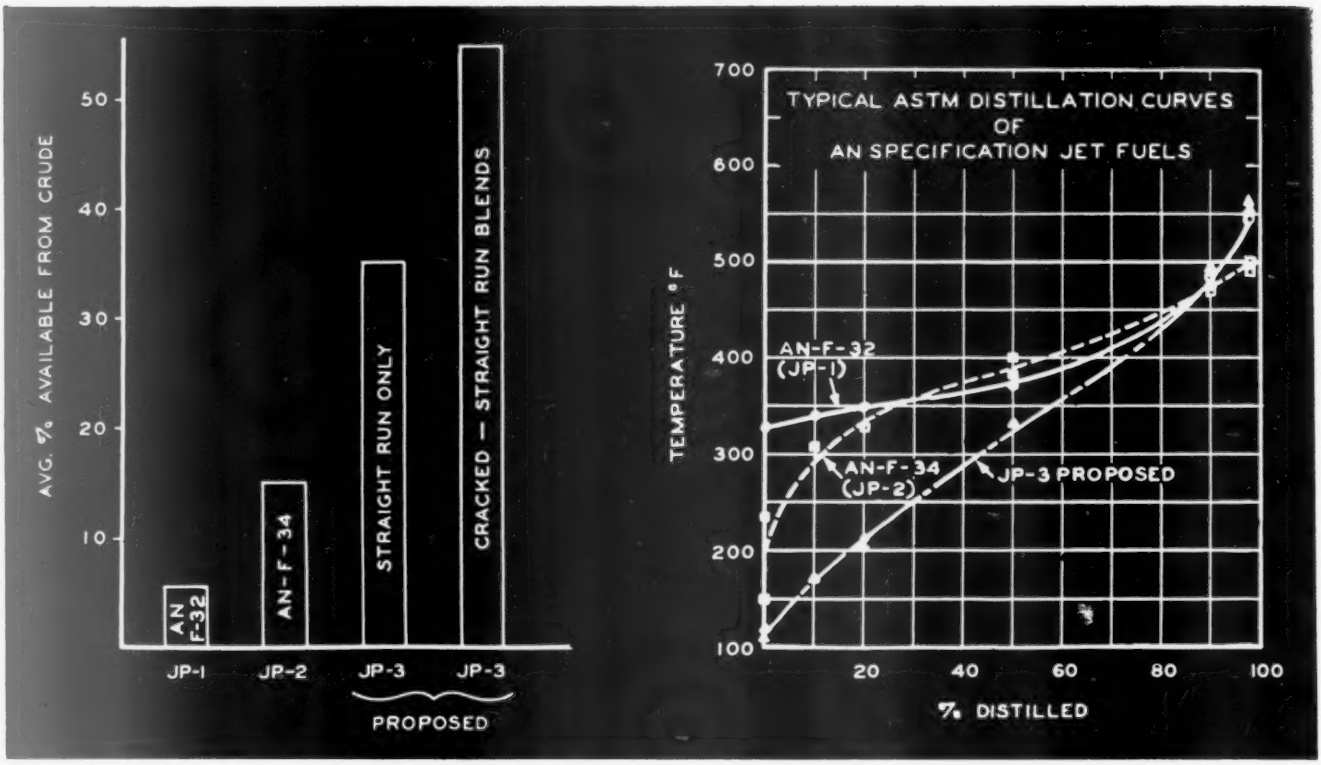

FIG. 8. Availability of jet fuels.

FIG. 9. Typical ASTM distillation curves of AN specification jet fuels.

the quantities of such fuels that could be made available in the event of a national emergency. This study has included a variety of crudes actually produced in this country. Two conditions that were made were: (1) First priority was given for jet fuel production; (2) existing refinery equipment would be utilized. By operating the refineries to produce the maximum quantity of each grade, the amounts that can be made available appear on Fig. 8 JP-1 grade of fuel, AN-F-32, (Table 2) is now required for all flight and ground operations of military aircraft. The quantity of this grade, essentially kerosine, which can be made available is approximately 6 per cent, which is relatively low. Freezing point and viscosity requirements appear to be the most restrictive requirements.

Until recently grade JP-2, AN-F-34, was indicated for ground testing of jet engines. This grade was cancelled a few weeks ago. The quantity of this grade that could be made available was approximately 15 per cent. Although the distillation range is wider than permitted in the JP-1 grade, other requirements of the specifications do not permit taking full advantage and hence the available quantity falls short of expectations for emergency requirements.

Specifications for the third grade, JP-3, have been drafted and it is expected ultimately to replace grade JP-1. The principal change from the JP-1 to the JP-3 grade is a much wider distillation range, which has been increased to approximately 100 to 600 F (Fig. 9) and a Reid vapor pressure of 5 to 8 lb. The quantity of the proposed JP-3 fuel that might be made available from straight run stocks is only approximately 30 to 35 per cent, or if cracked stocks can be utilized this quantity might be increased to approximately 55 per cent. The general feeling in the industry is that the proposed JP-3 grade will show satisfactory performance in the engine and will also meet the extreme low temperature requirements and finally can be made available in sufficient quantities in the event of an emergency.

● **Summary.** The following remarks will summarize the pertinent fuel requirments of the more popular jet engines:

1. *Volatility*: Fuels more volatile than JP-1, such as gasoline, offer advantages of easier starting, slightly better combustion efficiency, and lower deposits in some engines. Less volatile fuels, such as JP-2 grade or kerosine, offer advantages of freedom from vapor locking and evaporation losses and also reduced fire hazard.

2. *Composition*: Combustion efficiency, smoke and deposits are believed to be a function of the carbon-hydrogen ratio of the fuel component. The order of preference of fuels is paraffins, naphthenes, olefins, and aromatics. Distillate or straight run fuels are easier to burn than cracked fuels. Much work remains to be done on the latter type.

3. *Stability*: Better methods of gum test are believed necessary and much remains to be learned concerning the interpretation of these tests. It is doubtful whether much cracked stocks can be utilized with gum tests in proposed JP-3 grade of fuel.

4. *Freezing point*: Military requirements emphasize the importance of very low freezing point, which will have a marked effect upon the selection of jet fuel.

5. *Heating value*: Btu per gal and not per lb is becoming the criterion. Less volatile fuels and aromatic blends offer substantial increases in Btu per gal, and if all other factors remain constant, range of aircraft depends upon heating value.

The selection of fuel for the jet engine involves a compromise between engine design, operating conditions, and fuel properties. For military service it appears that the type fuel required in the near future will be a wide range type (B.P. 100-600 F), such as the proposed JP-3 grade, for reasons of availability and performance especially under extremely low temperatures. For commercial service a less volatile fuel (B.P. 320-600 F approximately) will be favored by commercial operators for reasons of reduced fire hazard. It is doubtful whether jet engines will be able to utilize heavy distillate fuels such as diesel oil and gas oil because of extremely low temperatures normally encountered and the problem of designing a lightweight high output engine to utilize such a fuel.

● **Acknowledgment.** The author wishes to express his appreciation to various members of The Texas Company, Technical and Research Division, the laboratories at Beacon, New York, and Port Arthur, Texas, and also to other members of the refining department staff for the material contributed and their valuable assistance in writing this paper.

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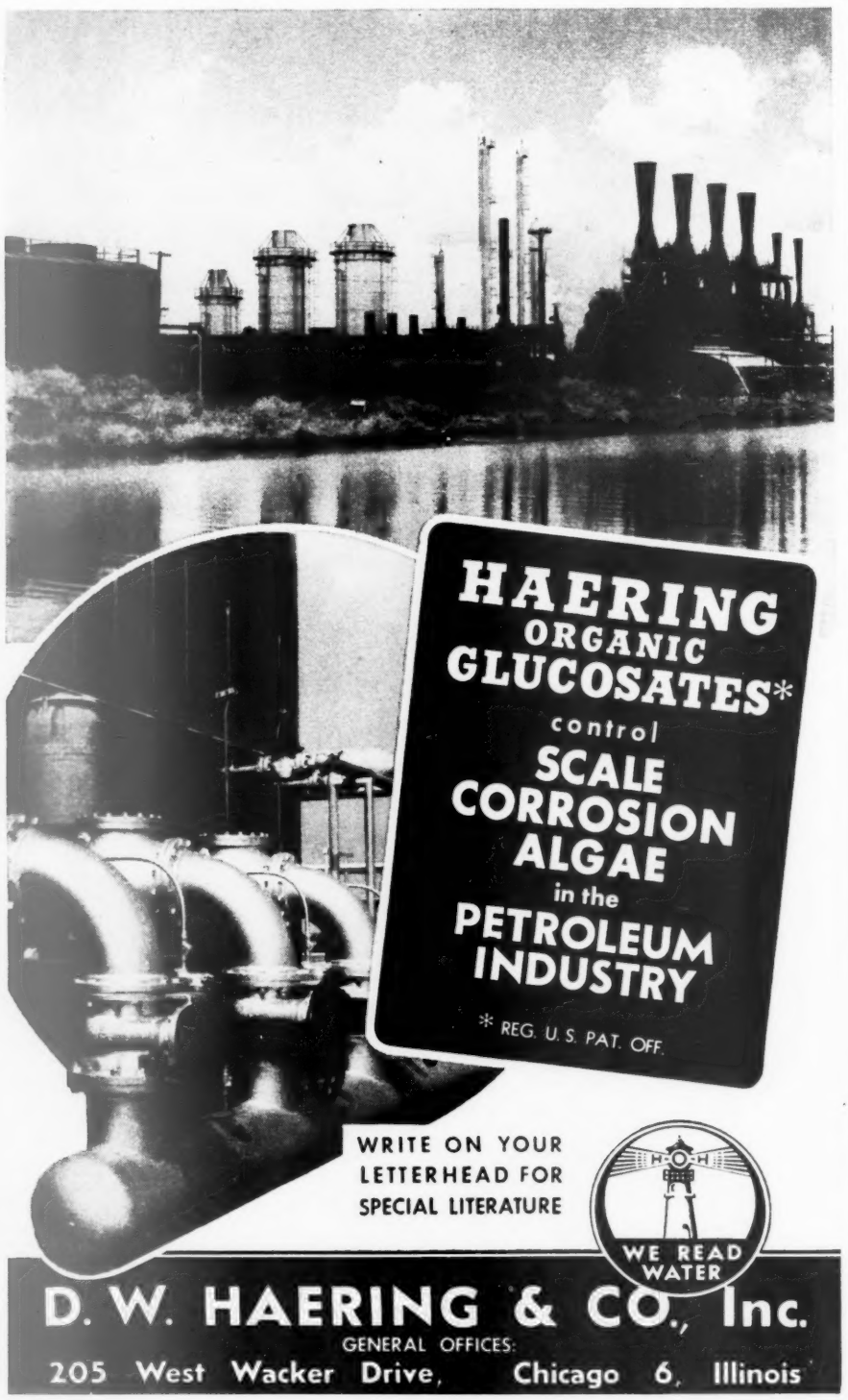
Bethlehem promotions

Bethlehem Supply Company announces the transfer and promotion of H. V. Harder, formerly district manager in the Rocky Mountain area, to special representative in the general sales office with headquarters in Tulsa. Harder has been employed by Bethlehem since February, 1941, in capacities of store manager and field representative in Kansas stores for two years and district manager in the Panhandle, North Central Texas, and Rocky Mountain districts during the last five years. Harder was affiliated with the Atlas Supply Company for 12 years prior to joining Bethlehem Supply.

E. S. Lewis, formerly district manager in the Illinois area, has been transferred to the Rocky Mountain area as district manager, replacing Harder. Lewis has had considerable experience in the supply business, having been with Bethlehem since November, 1943, and was previously employed by Bridgeport Machine of Wichita, Kansas, for five years in sales work.

G. B. Sager has been promoted to district manager of the Illinois area, replacing Lewis. Sager was formerly store manager and field representative of the Grayville, Illinois, store and has been employed by Bethlehem for nine years in various capacities.



Secretary of Universal

Stanley R. Wilson has been appointed secretary of Universal Oil Products Company, it is announced by David W. Harris, president of the company.

S. R. Wilson

Wilson was graduated from the University of Illinois in 1922 with a bachelor of science degree in industrial and mechanical engineering, and joined Universal the the same year. Later, he studied law at DePaul University, Chicago.

His experience has covered a wide range, both in the United States and in foreign operations. For several years he represented Universal abroad, with headquarters in London.

Later, as administrative assistant in the Chicago office, on contract and financial problems, he continued to handle foreign work. For three years he performed similar duties as administrative assistant in the New York office.

During the war, Wilson was in charge of all Universal's contract negotiations with the government, and up to the present has been in charge of the contract department of the company.

Store manager

John Herman Parker has been named manager of Oil Well Supply Company's Borger, Texas, store and Perry O. Gaut has resumed his duties as manager of the Pampa, Texas, store after an illness of several months, V. J. Waters, Central Midwest division manager for this U. S. Steel subsidiary, announces.

Parker, a U. S. Army veteran of World War II, joined "Oilwell" as a storeman in the Kilgore, Texas, store in October, 1946, and was a storeman in the Greggton, Texas, store at the time of his new appointment.

J. N. Tate, who has served as manager of the Pampa store in Gaut's absence, will remain at Pampa as the company's district representative, Waters said.

Manager of sales

Appointment of John B. Land as manager of sales for the petroleum and chemical industries section of General Electric's materials industries division has been announced by W. A. Wirene, division manager.

Land had previously been connected with the industrial sales division in G. E.'s Pittsburgh office. Prior to that he was district cable specialist of the Atlantic district, working out of the Philadelphia office.

A 1934 graduate of Notre Dame, where he received a B.S. degree in electrical engineering, Land joined G. E. as a test engineer, and later was assigned to the wire and cable division in Schenectady. His new appointment returns him to Schenectady.

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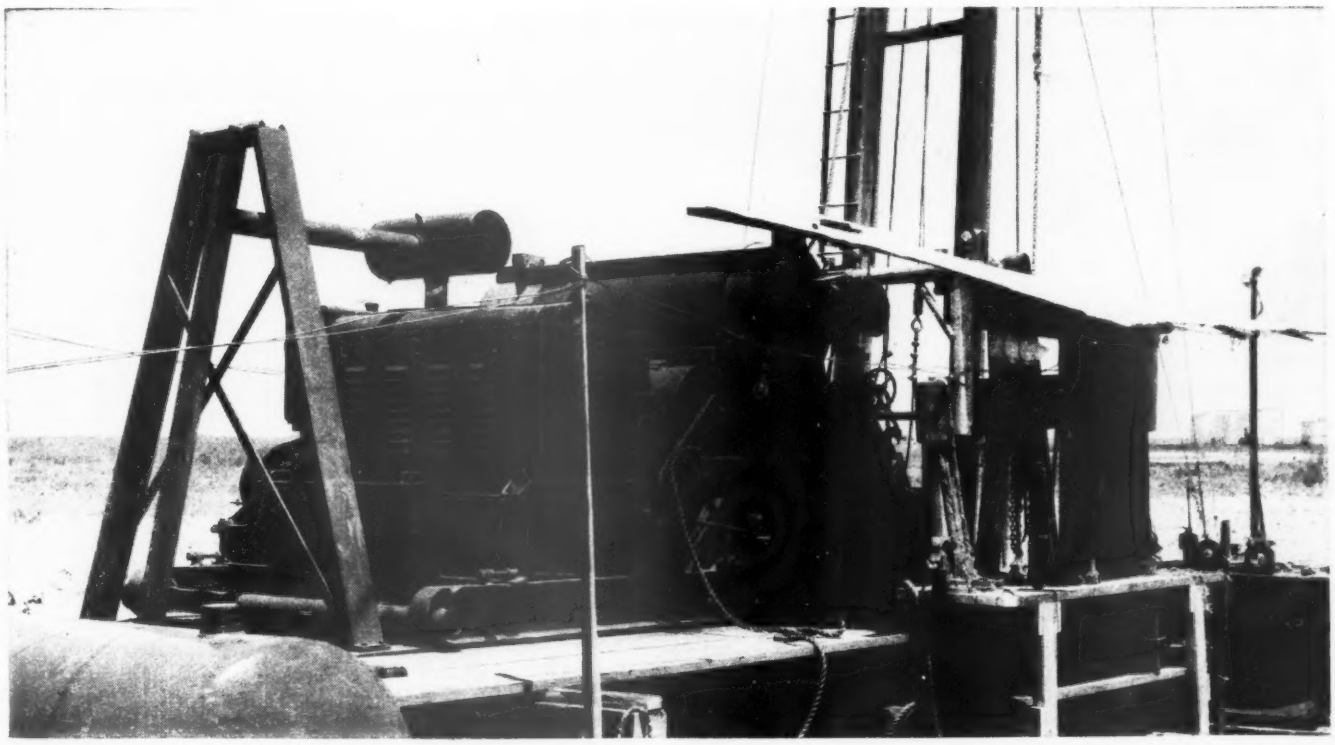


CUMMINS ENGINE COMPANY, INC. • COLUMBUS, INDIANA

New plant

The Chicago Bridge and Iron Company has let a contract to the American Bridge Company for an outside crane runway and Shop Building No. 2 at its new Salt Lake City, Utah, fabricating plant. Tanks and steel plate work are being fabricated in Shop No. 1, which was completed in June.

The new outside crane runway is 100 ft wide by 360 ft long. It will be used to unload incoming steel and pass it into Shop No. 1 or Shop No. 2 as required.

Shop No. 2 will be 125 ft wide by 420 ft long. It will be the same type construction as Shop No. 1 and will be equipped with a 20-ton overhead bridge crane. The foundations for Shop No. 2 will be started about the middle of August and the building will be completed in the Spring of 1949.

When Shop No. 2 is complete, the new Salt Lake City plant will be a completely integrated unit, with facilities for fabricating practically all of the company's diversified line of products. Shop No. 1 is equipped to fabricate flat-bottom tanks, Horton floating roofs, reservoirs and other structures of this same general type. Shop No. 2 will be equipped to fabricate Hortonspheres, Hortonspheroids, Hemispheroids, Waterspheres, Vaporspheres, elevated tanks, and other similar structures.

The new Chicago Bridge and Iron Company plant is at 550 West 17th South Street in Salt Lake City. A. N. Hopper, formerly chief draftsman for the company at its Greenville, Pennsylvania, plant, is manager.

Manager of sales

W. E. (Bill) Stiles, former Gulf Coast division manager in Houston for Core Laboratories, Inc., has been recently promoted to manager of sales for that organization. Stiles, a graduate petroleum engineer from Texas A. & M. College, was employed by Core Lab in 1942 as a field engineer specializing in field testing work. During the last six years he has held positions as reservoir engineer in the engineering department and as division engineer of the North Texas division. Prior to his association with Core Lab, he was engaged in coring equipment sales and service and subsurface engineering work.

W. E. Stiles

In his new capacity Stiles will direct the company's entire domestic and foreign sales program from Dallas.

Construction begins

Already expanding to meet the light-steel construction needs of South Texas, the McRan Company of Houston has begun work on its fabricating plant and warehouses on the Hempstead Highway, northwest of Houston.

Meanwhile, the firm is rapidly increasing its sales and service facilities throughout South Texas area, according to a company spokesman.

Dealers in Stran-Steel framing and Quonset buildings, the McRan Company reports a stepped-up demand for farm, industrial, and commercial uses of its products.

Officers of the McRan Company, which is franchised by the Great Lakes Steel Corporation, are John F. McComb, president; Henry E. Randle, vice president; Adolph Stuermer, secretary, and W. F. Weed, treasurer.

Expansion program

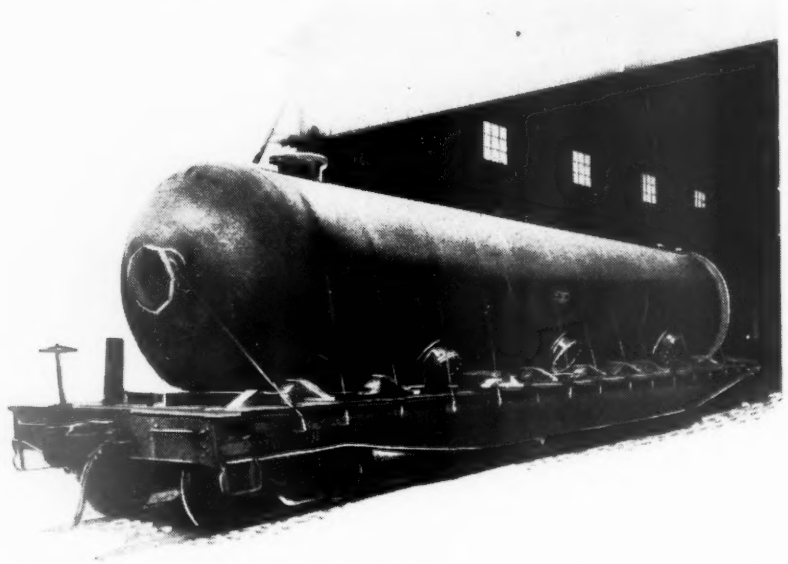
Greatly expanded machine shop and field service facilities for Southwest Texas and Mexico have been included by Hunt Tool Company in a recently completed expansion program at the Corpus Christi plant, W. J. Nutto, sales manager, announced.

With the additional machinery and welding equipment that has been installed at the new plant, Hunt is equipped to overhaul and repair complete drilling rigs and other drilling and production machinery, Nutto states.

A fleet of field welding trucks and boilers repair trucks has been added to the field service facilities. In addition, complete fishing tool and side wall coring services have been established at the Corpus Christi plant. R. H. King is division manager.

PRESSURE VESSELS

- Towers
- Absorbers
- Scrubbers
- Drums
- Pressure Storage
- Processing Equipment



OUR SHOP FACILITIES INCLUDE:

- 31,000 sq. ft. of CRANE SERVED FLOOR SPACE.
- 80,000 lbs. CRANE AND TRUNNION DESIGN CAPACITY.
- ROLLS CAPABLE OF ROLLING 1½" Steel to 3' Diameter in 10' RINGS.
- STRESS RELIEVING FURNACE... Capable of handling Vessels 6' in diameter, by 70' LONG.
- RADIUM CAPSULES FOR RADIOGRAPHING.
- AUTOMATIC SUBMERGED ARC WELDING IF DESIRED.
- FULLY QUALIFIED MANUAL WELDERS AND SUBMERGED ARC PROCESS OPERATORS.
- HEAD STOCK UP TO 10' x 600 lbs. per sq. inch W.P.
- FULL-TIME NATIONAL BOARD INSPECTION.

Send Inquiries to REFINERY EQUIPMENT DEPARTMENT
BUTANE EQUIPMENT CO., INC.
Box 9275
DALLAS, TEXAS Telephone: LD-140

the Petroleum Engineer's CONTINUOUS TABLES

a daily reference for operating men

INSTALLMENT No. 134

A valuable and regular feature of *The Petroleum Engineer,* the Continuous Tables, now in their twelfth year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.* Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have been developed as a result of suggestions for new tables, direct contributions and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944 issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue; 98-100, inclusive, in the October, 1945, issue; 101-103, inclusive, in the January, 1946, issue; 104-106, inclusive, in the April, 1946, issue; 107-109, inclusive, in the July, 1946, issue; 110-112, inclusive, in the October, 1946, issue; 113-115, inclusive, in the January, 1947, issue; 116-118, inclusive, in the April, 1947, issue; 119-121, inclusive, in the July, 1947, issue; 122-124, inclusive, in the October, 1947, issue; 125-127, inclusive, in the January, 1948, issue; 128-130, inclusive, in the April, 1948, issue; 131-133, inclusive, in the July, 1948, issue.

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Factors in the selection and use of sucker rod pumps (sheet 4)	P 514.1	207	Aug.
Properties of high yield strength seamless pipe (sheet 3)	P 615.23	201	Aug.
Properties of high yield strength seamless pipe (sheet 4)	P 615.23	203	Aug.
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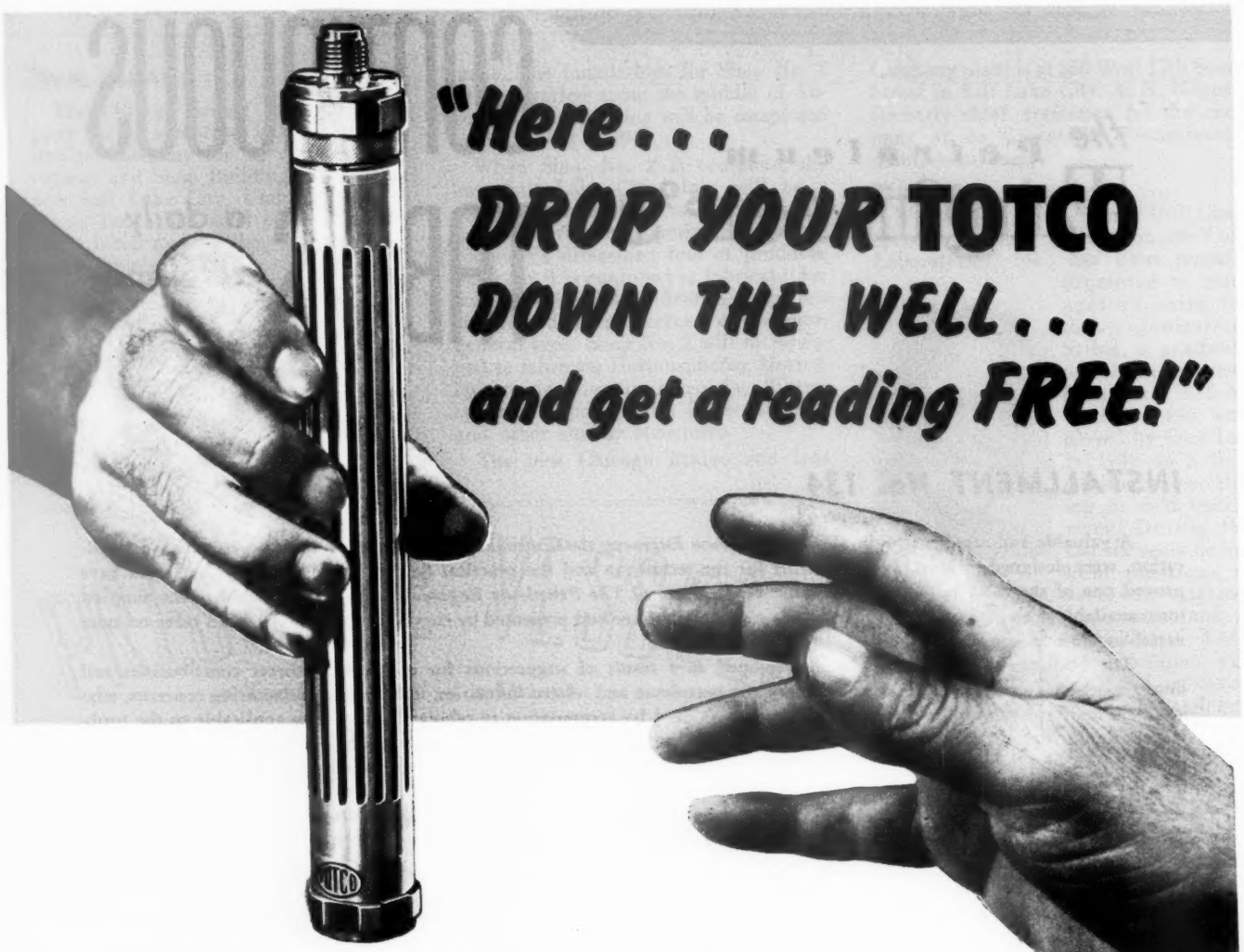
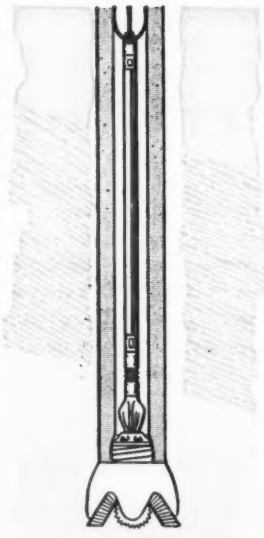
Toledo Pipe Threading Machine Co. (sheet 4)	204	Aug.	P 615.23
Torrington Company (sheet 3)	202	Aug.	P 615.23
Visco Products Co., Inc. (sheet 2)	198	Aug.	P 425.215.1



"Here... DROP YOUR TOTCO DOWN THE WELL... and get a reading FREE!"

"For Pete's sake, man, don't pass up a chance to get something for nothing. You're going to pull the string to change bits; you've got the equipment for dropping the Totco, haven't you? Well then, DROP it before you pull the bit. It costs you only a few minutes more — disconnect the kelly, drop in the go-devil, re-connect the kelly and run back to bottom. Thirty seconds after your Totco has recorded, start out of the hole. How much time is all that . . . not more than a few minutes. Well, you'll certainly trade a few minutes for an accurate bottom-hole record. Why, it's getting your reading practically for FREE! . . . No, you won't get *all* your Totco readings by dropping it — unless you're making mighty frequent round-trips with the bit. But you will get a lot of them, at next to no cost in time. So drop that Totco, man!"



TOTCO

TECHNICAL OIL TOOL CORP., Ltd.
1057 N. LA BREA AVENUE • LOS ANGELES, CALIFORNIA

Exclusive Distributors: California — REPUBLIC SUPPLY COMPANY OF CALIFORNIA • Domestic (outside California) — CONTINENTAL SUPPLY COMPANY • Canada — OIL WELL SUPPLY COMPANY • Export (except Canada) — LUCEY EXPORT CORP., New York

CLEARANCE RATIO CHART—CASING PROTECTORS

Drill pipe and protector data | Casing data

Clearance ratio = area "D" minus area "C" divided by area "B"

Drill pipe size (OD in.)	Inside diameter of tool joint (ID in.)	Internal area of tool joint, area "B"	OD of protector on pipe (in.)	Area of protector on pipe, area "C"	5				5½					5¾					6				6⅝					7									
					Wt. 18	Wt. 15	Wt. 13	Wt. 11.50	Wt. 23	Wt. 20	Wt. 17	Wt. 15.50	Wt. 14	Wt. 13	Wt. 23	Wt. 22.50	Wt. 20	Wt. 19.50	Wt. 17	Wt. 14	Wt. 23	Wt. 20	Wt. 18	Wt. 15	Wt. 32	Wt. 28	Wt. 24	Wt. 20	Wt. 17	Wt. 38	Wt. 35	Wt. 32	Wt. 29	Wt. 26	Wt. 23	Wt. 20	Wt. 17
					ID 4.276 Int area 14.36 sq in. "D"	ID 4.408 Int area 15.26 sq in. "D"	ID 4.494 Int area 15.86 sq in. "D"	ID 4.560 Int area 16.33 sq in. "D"	ID 4.670 Int area 17.13 sq in. "D"	ID 4.778 Int area 17.93 sq in. "D"	ID 4.892 Int area 18.80 sq in. "D"	ID 4.950 Int area 19.24 sq in. "D"	ID 5.012 Int area 19.73 sq in. "D"	ID 5.044 Int area 19.98 sq in. "D"	ID 4.990 Int area 19.56 sq in. "D"	ID 4.990 Int area 19.56 sq in. "D"	ID 5.090 Int area 20.35 sq in. "D"	ID 5.090 Int area 20.35 sq in. "D"	ID 5.190 Int area 21.16 sq in. "D"	ID 5.290 Int area 21.98 sq in. "D"	ID 5.240 Int area 21.57 sq in. "D"	ID 5.352 Int area 22.50 sq in. "D"	ID 5.424 Int area 23.11 sq in. "D"	ID 5.524 Int area 23.97 sq in. "D"	ID 5.675 Int area 25.29 sq in. "D"	ID 5.791 Int area 26.34 sq in. "D"	ID 5.921 Int area 27.53 sq in. "D"	ID 6.049 Int area 28.74 sq in. "D"	ID 6.135 Int area 29.56 sq in. "D"	ID 5.920 Int area 27.53 sq in. "D"	ID 6.004 Int area 28.31 sq in. "D"	ID 6.094 Int area 29.17 sq in. "D"	ID 6.184 Int area 30.04 sq in. "D"	ID 6.276 Int area 30.94 sq in. "D"	ID 6.366 Int area 31.83 sq in. "D"	ID 6.456 Int area 32.74 sq in. "D"	ID 6.538 Int area 33.57 sq in. "D"
2⅜	1.750	2.41	3⅞	11.79	x	1.4	1.7	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	9.1	
			4½	15.90	x	x	x	x	x	x	1.2	1.4	1.6	1.7	1.5	1.5	1.8	1.8	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
			4¹⁵⁄₁₆	19.15	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	x	1.4	1.6	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	
2⅞	2.125	3.55	4⅜	13.77	x	x	x	x	x	x	1.4	1.5	1.7	1.8	1.6	1.6	1.9	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
			4⅜	15.03	x	x	x	x	x	x	x	1.2	1.3	1.4	1.3	1.3	1.5	1.5	1.7	2.0	1.8	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	
			4½	16.35	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.4	1.6	1.5	1.7	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	
			5⅛	20.13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.5	1.8	o	o	o	o	o	o	o	o	o	o	
3½	2.688	5.67	4¹¹⁄₁₆	17.26	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.4	1.6	1.8	2.0	o	1.8	2.0	o	o	o	o	o	o
			5	19.64	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.4	1.6	1.7	1.4	1.5	1.7	1.8	2.0	o	o	o	
			5¼	21.65	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.4	x	1.2	1.5	1.5	1.6	1.8	2.0	o	
			5½	23.76	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.3	1.4	1.6	1.7		
			6⅛	29.47	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
4	3.156	7.82	5⅞	23.22	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3			
			5¹¹⁄₁₆	25.41	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			5⅞	27.11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			5⅞	27.11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6⅞	32.55	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6¹¹⁄₁₆	35.13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			7⅛	39.18	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			7⅝	42.00	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
4½	3.750	11.05	5⅞	27.11	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6¼	30.68	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6¼	30.68	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6⅜	31.92	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6½	33.18	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6⅝	33.82	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6¹³⁄₁₆	36.45	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6⅞	37.12	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			7	38.49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			7⅛	43.45	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			7⅝	45.66	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
5	3.750	11.05	6¼	30.68	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6¹¹⁄₁₆	35.13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6¹¹⁄₁₆	35.13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			6¾	35.79	x	x	x	x																x	x	x	x	x	x	x	x	x	x			
			6¹³⁄₁₆	36.45	x	x	x	x																x	x	x	x	x	x	x	x	x	x			
			6¹⁵⁄₁₆	37.80	x	x	x	x																x	x	x	x	x	x	x	x	x	x			
			7	38.49	x	x	x	x																x	x	x	x	x	x	x	x	x	x			
			7⅛	40.57	x	x	x	x																x	x	x	x	x	x	x	x	x	x			
			7¼	41.28	x	x	x	x																x	x	x	x	x	x	x	x	x	x			
			7⅜	42.72	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			7¾	47.17	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			8	50.27	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
5⅜	4.000	12.57	7⅜	40.57	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			7⅜	43.45	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			7¹¹⁄₁₆	46.42	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			7¹¹⁄₁₆	46.42	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			8⅜	55.09	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
6⅝	5.000	19.64	8⅜	57.58	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			8⅜	57.58	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			8¹³⁄₁₆	60.99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			9⅛	64.50	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
			9³⁄₁₆	66.30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			

x—Clearance ratios less than 1.0.
1.4—Clearance ratios shown between 1.0 and 2.0.
o—Ample clearance ratios.

Notes: 1. All tool joint inside diameters are given for A.P.I. internal flush except 5⅜ and 6⅝ which are A.P.I. full hole sizes.
2. All protectors used in 13" casing or larger have ample clearance.

—Courtesy Patterson-Ballagh Division of Byron Jackson Company

M.O. JOHNSTON *Presents*

THE MASON hydra-line

(PATENT NO. 2240794)

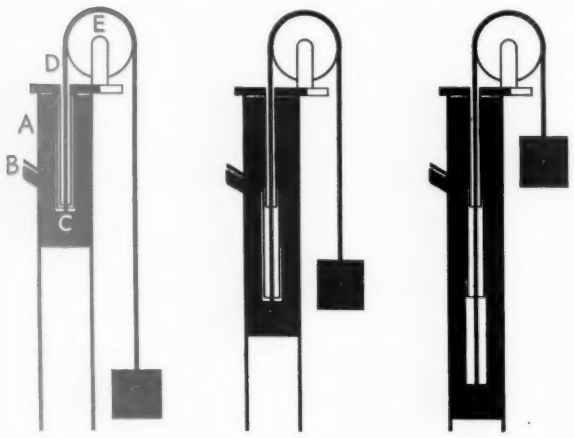
The most talked of equipment at the oil show!

Combines hydraulics with the wire line for hoisting operations in drilling rigs, pulling rigs and pumping units

THE RIG WITHOUT DRAWWORKS OR TRAVELING BLOCK

THE MASON HYDRA-LINE RIG departs from conventional means of hoisting operations by combining the simplicity and smoothness of hydraulic power with the utility and flexibility of wire rope to completely eliminate drawworks and traveling block assemblies. With the HYDRA-LINE, raising and lowering are accomplished by simple manipulation of a single micro-sensitive control. This revolutionary new principle provides unlimited number of hoisting speeds, greater "hook" horsepower per input horsepower, virtually unlimited derrick height and drilling depth, fluid cushioning to minimize load shocks, sealed-in oil bathed protection for all working parts and a rig and crew safety factor not found in any conventional type rig!

The Hydra-Line principle is simple



1 Load at rest with telescoping tube and piston assembly (C) in fully retracted position.

2 Fluid entering port (B) forces piston down to raise load. Note telescoping tubes.

3 Tubes extended and load at maximum height. Weight of load lifts piston when variable orifice is opened to bleed.

THE MASON HYDRA-LINE consists of only five principal parts: a smooth-bore steel cylinder (A), sealed top and bottom and with one common input-output port (B); a piston and telescoping tube assembly (C); a wire line (D) passing through the telescoping tubes and secured to the piston and a large diameter crown sheave (E), positioned to carry the wire line from the piston to load being raised or lowered.

Fluid introduced into the cylinder above the piston forces the piston downward to lift load suspended from wire line—fluid bled from the cylinder plus air compressed by piston during downtravel, forces the piston upward to lower the load.

Total load capacity is dependent upon number of cylinders used. A Hydra-Line Rig employing two cylinders easily raises a 150,000 lb. hook load with less than 700 PSI on the piston!

ADVANTAGES OF THE HYDRA-LINE PRINCIPLE

LARGE PISTON AREA *permits low unit pressure for all hoisting operations.*

NUMBER OF TELESCOPING TUBES *limited only by ratio with piston area—cross-sectional area is less than 10% of the total piston area.*

VIRTUALLY NO LIMIT TO STROKE LENGTH—*column loading on telescoping tubes is negligible—a 200' stroke is as feasible as a 10' stroke.*

MAIN CYLINDERS ARE STRUCTURAL PART OF MAST OR DERRICK—*provide sufficient strength to carry rig-rated load.*

LOADS "FLOATED" DOWNWARD AT ANY SPEED—*a variable orifice controls bleeding of fluid from cylinders.*

HOOK CAN BE DROPPED RAPIDLY WITH LIGHT LOADS—*air compressed in cylinder by piston downtravel "boosts" piston up to lower light loads.*

THE HYDRA-LINE IS IDEAL FOR—

HEAVY DUTY DEEP WELL DRILLING RIGS

with capacities to 500 tons—Derrick heights to 210' 0"—Drilling depths to 20,000' or deeper—No substructure required except for derrick.

FULLY PORTABLE & SEMI-PORTABLE DRILLING & WORKOVER RIGS

with capacities to 125 tons—Derrick heights to 112' 0"—Drilling depths to 10,000' per single unit. By placing two units face to face load and depth capacities double.

LIGHT PORTABLE PULLING & SHALLOW DRILLING UNITS

with capacities from 5 tons to 50 tons—Mast heights from 20'0" to 60'0"—Truck mounted.

COMBINATION PUMPING & PULLING UNITS

with variable pump strokes up to 60'—Central power or individually operated—Pumping and pulling of rods and tubing accomplished with the same unit.

FOR FURTHER INFORMATION CONTACT

THE hydra-line DIVISION

OF THE JOHNSTON ENTERPRISES

3035 ANDRITA STREET, LOS ANGELES 41, CALIF.

CLEARANCE RATIO CHART—CASING PROTECTORS

Drill pipe and protector data — Casing Data

Clearance ratio = area "D" minus area "C" divided by area "B"

Drill pipe size (OD in.)	Inside diameter of tool joint (ID in.)	Internal area of tool joint, area "B"	OD of protector on pipe (in.)	Area of protector on pipe, area "C"	7⅝						8⅛					8⅝							9					9⅝							10¾					11¾				
					Wt. 39 ID 6.625 Int area 34.47 sq in. "D"	Wt. 33.70 ID 6.765 Int area 35.94 sq in. "D"	Wt. 29.70 ID 6.875 Int area 37.12 sq in. "D"	Wt. 26.40 ID 6.969 Int area 38.14 sq in. "D"	Wt. 24 ID 7.025 Int area 38.76 sq in. "D"	Wt. 20 ID 7.125 Int area 39.87 sq in. "D"	Wt. 42 ID 7.125 Int area 39.87 sq in. "D"	Wt. 39.50 ID 7.185 Int area 40.55 sq in. "D"	Wt. 35.50 ID 7.285 Int area 41.68 sq in. "D"	Wt. 32 ID 7.385 Int area 42.83 sq in. "D"	Wt. 28 ID 7.485 Int area 44.00 sq in. "D"	Wt. 49 ID 7.511 Int area 44.31 sq in. "D"	Wt. 44 ID 7.625 Int area 45.66 sq in. "D"	Wt. 40 ID 7.725 Int area 46.87 sq in. "D"	Wt. 36 ID 7.825 Int area 48.09 sq in. "D"	Wt. 32 ID 7.921 Int area 49.28 sq in. "D"	Wt. 28 ID 8.017 Int area 50.48 sq in. "D"	Wt. 24 ID 8.097 Int area 51.49 sq in. "D"	Wt. 55.20 ID 7.812 Int area 47.93 sq in. "D"	Wt. 45 ID 8.032 Int area 50.67 sq in. "D"	Wt. 40 ID 8.150 Int area 52.17 sq in. "D"	Wt. 38 ID 8.196 Int area 52.76 sq in. "D"	Wt. 34 ID 8.290 Int area 53.98 sq in. "D"	Wt. 53.50 ID 8.535 Int area 57.21 sq in. "D"	Wt. 47 ID 8.681 Int area 59.19 sq in. "D"	Wt. 43.50 ID 8.755 Int area 60.20 sq in. "D"	Wt. 40 ID 8.835 Int area 61.31 sq in. "D"	Wt. 36 ID 8.921 Int area 62.51 sq in. "D"	Wt. 32.30 ID 9.001 Int area 63.63 sq in. "D"	Wt. 29.30 ID 9.063 Int area 64.51 sq in. "D"	Wt. 55.50 ID 9.760 Int area 74.82 sq in. "D"	Wt. 51 ID 9.850 Int area 76.20 sq in. "D"	Wt. 45.50 ID 9.950 Int area 77.76 sq in. "D"	Wt. 40.50 ID 10.050 Int area 79.33 sq in. "D"	Wt. 32.75 ID 10.192 Int area 81.58 sq in. "D"	Wt. 60 ID 10.772 Int area 91.13 sq in. "D"	Wt. 54 ID 10.880 Int area 92.97 sq in. "D"	Wt. 47 ID 11.000 Int area 95.03 sq in. "D"	Wt. 42 ID 11.084 Int area 96.49 sq in. "D"	Wt. 38 ID 11.150 Int area 97.64 sq in. "D"
			3⅞	11.79	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
2⅜	1.750	2.41	4½	15.90	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			4 15/16	19.15	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			4 3/16	13.77	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
2⅞	2.125	3.55	4⅜	15.03	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			4 9/16	16.35	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			5 1/16	20.13	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			4 11/16	17.26	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			5	19.64	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
3½	2.688	5.67	5¼	21.65	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			5½	23.76	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6⅛	29.47	x	x	1.4	1.5	1.6	1.8	1.8	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			5 7/16	23.22	1.4	1.6	1.8	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			5 11/16	25.41	1.2	1.3	1.5	1.6	1.7	1.8	1.8	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			5⅞	27.11	x	x	1.3	1.4	1.5	1.6	1.6	1.7	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
4	3.156	7.82	5⅞	27.11	x	x	1.3	1.4	1.5	1.6	1.6	1.7	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6 7/16	32.55	x	x	x	x	x	x	x	x	1.2	1.3	1.5	1.5	1.7	1.8	2.0	o	o	o	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6 11/16	35.13	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.5	1.7	1.8	2.0	o	1.6	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			7 1/16	39.18	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.3	1.4	1.6	x	1.5	1.7	1.7	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			7 5/16	42.00	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	x	x	1.3	1.4	1.5	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			5⅞	27.11	x	x	x	x	x	1.2	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	o	o	o	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6¼	30.68	x	x	x	x	x	x	x	x	x	x	1.2	x	1.4	1.5	1.6	1.7	1.8	1.9	1.6	1.8	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6¼	30.68	x	x	x	x	x	x	x	x	x	x	1.2	x	1.4	1.5	1.6	1.7	1.8	1.9	1.6	1.8	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6⅜	31.92	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.4	1.5	1.6	1.7	1.8	1.5	1.7	1.8	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6½	33.18	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.5	1.6	1.7	1.3	1.6	1.7	1.8	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
4½	3.750	11.05	6 9/16	33.82	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.4	1.5	1.6	1.3	1.5	1.7	1.7	1.8	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6 13/16	36.45	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.4	x	1.3	1.4	1.5	1.6	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6⅞	37.12	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	x	1.2	1.4	1.4	1.5	1.8	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			7	38.49	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	x	x	1.2	1.3	1.4	1.7	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			7 7/16	43.45	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.3	1.4	1.5	1.6	1.7	1.8	1.9	o	o	o	o	o	o	o	o	o	o
			7⅝	45.66	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.4	1.5	1.6	1.7	o	o	o	o	o	o	o	o	o	o
			6¼	30.68	x	x	x	x	x	x	x	x	x	x	1.2	1.2	1.4	1.5	1.6	1.7	1.8	1.9	1.6	1.8	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6 11/16	35.13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.4	1.5	1.2	1.4	1.5	1.6	1.7	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6 11/16	35.13	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.4	1.5	1.2	1.4	1.5	1.6	1.7	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6¾	35.79	x															1.2	1.3	1.4	x	1.3	1.5	1.5	1.6	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			6 13/16	36.45	x															1.2	1.3	1.4	x	1.3	1.5	1.5	1.6	1.9	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
5	3.750	11.05	6 15/16	37.80	x															x	x	1.2	x	1.2	1.3	1.4	1.5	1.8	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			7	38.49	x															x	x	1.2	x	x	1.2	1.3	1.4	1.7	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o	o
			7 3/16	40.57	x															x	x	x	x	x	x	x	1.2	1.5	1.7	1.8	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o	o
			7¼	41.28	x															x	x	x	x	x	x	x	x	1.4	1.6	1.7	1.8	1.9	2.0	o	o	o	o	o	o	o	o	o	o	o	o
			7⅜	42.72	x															x	x	x	x	x	x	x	x	1.3	1.5	1.6	1.7	1.8	1.9	2.0	o	o	o	o	o	o	o	o	o	o
			7¾	47.17	x															x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.4	1.5	1.6	o	o	o	o	o	o	o	o	o	o
			8	50.27	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	o	o	o	o	o	o	o	o	o	o
			7 3/16	40.57	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.3	1.5	1.6	1.6	1.7	1.8	1.9	o	o	o	o	o	o	o	o	o	o
			7 7/16	43.45	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.3	1.3	1.4	1.5	1.6	1.7	o	o	o	o	o	o	o	o	o	o
5 9/16	4.000	12.57	7 11/16	46.42	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.4	1.4	o	o	o	o	o	o	o	o	o	o
			7 11/16	46.42	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.3	1.4	1.4	o	o	o	o	o	o	o	o	o	o
			8⅜	55.09	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.6	1.7	1.8	1.9	o	o	o	o	o	o
			8 9/16	57.58	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.7	1.8	1.9	2.0	2.0
			8 9/16	57.58	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.2	1.7	1.8	1.9	2.0	2.0
6⅝	5.000	19.64	8 13/16	60.99	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.5	1.6	1.7	1.8	1.9
			9 1/16	64.50	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.4	1.4	1.6	1.6	1.7
			9 3/16	66.30	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1.3	1.4	1.5	1.5	1.6

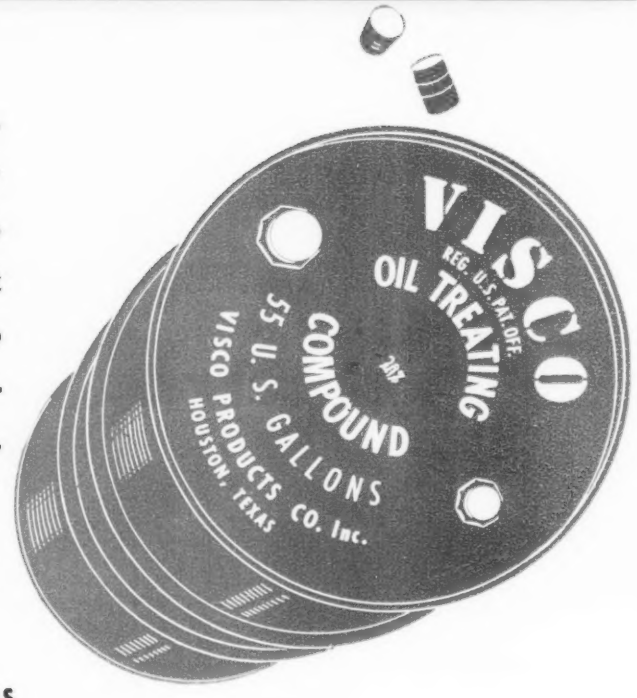
x-Clearance ratios less than 1.0.
1.4-Clearance ratios shown between 1.0 and 2.0.
o-Ample clearance ratio.

Notes: 1. All tool joint inside diameters are given for A.P.I. internal flush except 5 9/16 and 6⅝ which are A.P.I. full hole sizes.
2. All protectors used in 13" casing or larger have ample clearance.

—Courtesy Patterson-Ballagh Division of Byron Jackson Company

Sure Sign OF EFFICIENT EMULSION-BREAKING

THE Visco formula number on its products is your assurance of exact uniformity .... from month to month—year to year. Inside the blue barrels are efficient chemicals of *reliable* quality. Your Visco Representative can prove these statements to you ... Ask him to do it. Soon.



VISCO PRODUCTS COMPANY
INCORPORATED
City National Bank Building
Houston 1, Texas

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Visco DEHYDRATING AND DESALTING CHEMICALS
WHEREVER COST AND EFFICIENCY COUNT

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FACTORS IN THE SELECTION AND USE OF SUCKER ROD PUMPS

The following equation can be used to determine slippage losses past pump plungers with sufficient accuracy for most purposes:

$$Q = \frac{\pi D P C^3}{\mu L \times 2.32 \times 10^{-7}} \quad . \quad . \quad . \quad (1)$$

Where:
Q = slippage loss, cu in. per min,
D = plunger diameter, in.,
P = differential pressure across plunger, psi,
C = diametral clearance, in.,
L = length of plunger, in.,
μ = absolute viscosity, centipoises.

A specific application of this equation will serve to illustrate the importance of plunger fits for a pump of a particular bore and stroke, operating with various plunger fits, in fluids of various viscosities.

If we assume a 2¼-in. bore pump operating with a pressure differential of 2000 psi between the two ends of a 48-in. plunger, at a rate of fifteen 48-in. strokes per minute, in oil having a viscosity of 3 centiposes, and a diametral clearance of 0.003 in. between plunger and barrel, equation (1) becomes:

$$Q = \frac{\pi \times 2.25 \times 2000 \times 2.7 \times 10^{-8}}{3 \times 48 \times 2.32 \times 10^{-7}}$$

$$= 11.43 \text{ cu in. per min.}$$

Assuming that the volume of the barrel below the plunger is completely filled during the up-stroke, this rate of leakage can occur only during the up-stroke, or approximately one-half of the total time, and the net slippage past the plunger is 5.72 cu in. per min, or 0.85 bbl per day. The displacement of a 2¼-in. pump operating at fifteen 48-in. strokes per minute is 426 bbl per day and the slippage in this case is only about 0.2 per cent, which is insignificant. The results with this and other plunger clearances with 3 centipoise oil are shown in Table 1.

In the case of 0.020-in. plunger clearance, the slippage loss when pumping water with a viscosity of 1 centipoise would be 755 bbl per day, which is more than the pump displacement and it would be impossible to pump water to the surface, or to a level giving 2000 psi pressure differential across the plunger. When pumping oil with a viscosity of 100 centipoises, however, the slippage would be only about 7.5 bbl per day, or less than 1.8 per cent of the pump displacement, and a clearance of 0.020 in. is reasonably satisfactory for these conditions.

It is pointed out that slippage losses result directly in power losses, and it requires the same power to lift the plunger with 90 per cent of the fluid slipping past the plunger during the up-stroke as is required with 1 per cent or less, slip. The energy dissipated in slippage losses results in an increase in temperature of the oil within the pump, and a decrease in viscosity, which further increases slippage losses. Excessive slippage losses also increase the chances of forming emulsions, where water is produced with the oil.

TABLE 1. Losses resulting from slippage past 2¼-in. pump plunger 48 in. long with 2000 psi pressure differential, 3 centipoise oil, with various plunger fits. Also slippage in percentage of pump displacement with fifteen 48-in. strokes per min.

Diametral clearance, in.	Slippage rate, cu in. per min.	Slippage loss in pump		
		Cu in. per min.	Bbl per day	Per cent of pump displacement
0.003	11.43	5.72	0.85	0.2
0.006	91.5	45.8	6.8	1.6
0.010	424.	212.	31.5	7.4
0.020	3390.	1695.	251.8	59.2

TABLE 2. Velocity and pressure drop through regular and oversize gas anchors 10 ft long—54-in. stroke, 20 spm, 100 centipoise oil.

Regular anchor					Oversize anchor				
Pump bore, in.	Pipe size, in.	Max. vel, fps	Type flow	Pressure drop, psi	Pipe size, in.	Max. vel, fps	Type flow	Pressure drop, psi	Decrease in pressure drop, per cent
1¾	¾	21.3	Turbulent	21.2	1¼	6.43	Viscous	2.3	89
2¼	1	21.6	Turbulent	16.7	1½	9.19	Viscous	2.4	86
2¾	1½	13.7	Turbulent	4.5	2	8.35	Turbulent	1.3	71

There are two precautions to take to minimize the adverse effects of vapors and gases:

1. The compression ratio should be made as high as possible. This is accomplished by using a closed-cage type valve below the plunger with a stationary barrel pump, or a valve above the plunger with a traveling barrel type pump; spacing the pump so the traveling valve and standing valve come as near to each other as possible at the lowest position of the rods, without making contact; and using as long a stroke as possible with the equipment available.

2. Flow velocities and turbulence at the pump inlet should be kept at a minimum. This is accomplished by using the largest standing valve possible, and a suitable gas anchor with the largest possible flow passages.

In general, where gas anchors are used, the pressure drop through the gas anchor pipe is greater than that through the standing valve because of the greater length of the gas anchor flow passage, and in many cases the ID of the gas anchor is less than that of the standing valve. It is important to make this connection as large as possible for handling extreme gassy or volatile fluids. It has been customary in the past to attach the gas anchor directly to the threaded connection in the tapered cup nut or valve body, and this thread for a 1¾-in. valve was usually a ¾-in. pipe thread. A 2¼-in. valve is commonly equipped with a connection for 1-in. line pipe, and 1½-in. line pipe is often used with a 2¾-in. standing valve. Fig. 5 shows a design for a standing valve seating shoe that permits the use of larger gas anchor connections in standard line pipe sizes, and Table 2 shows the effect on flow velocities and pressure drops for a particular case when using a 10-ft gas anchor and substituting 1¼-in., 1½-in., and 2-in. line pipe sizes for the ¾-in., 1-in., and 1½-in. sizes previously used.

FIG. 4. Bottom lock hold-down and shoe assembly.

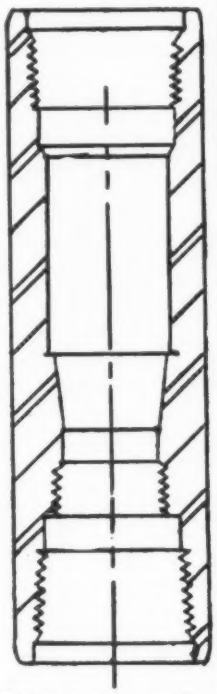

FIG. 5. Standing valve seating shoe with oversize anchor connection.

Taken from the article "Factors to be considered in the selection of subsurface sucker-rod pumps," by R. L. Chenault, presented before The American Society of Mechanical Engineers, Houston, Texas, October 5-8, 1947, and published in *The Petroleum Engineer*, January, 1948, pages 132 to 150, inclusive.

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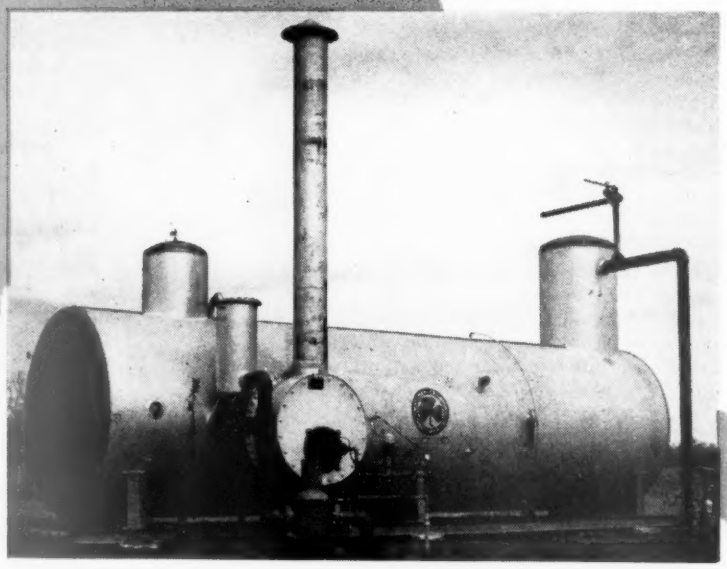

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PROPERTIES OF HIGH YIELD STRENGTH SEAMLESS PIPE

A weldment of 52,000 psi minimum yield strength material should not be expected to have the same bending properties as a weldment of 35,000 psi minimum yield strength material due to the difference in minimum elongation. In addition to its intended function of indicating the defects that may be present in the weld, the bend test is to a great extent a measure of the ductile properties of the weldment at the outer fibers of the bend. It can be recognized, therefore, that the conventional bend test for low yield strength material is not truly applicable to sound welds of high yield strength material. If a test of this type is to be applicable for all types of welded line pipe joints, there should be some modification that more clearly recognizes varying levels of ductility, depending upon the strength of the material tested. It is believed that a practical approach to such a modification would be to vary the radius of the bend test so that the maximum elongation in making a 180-deg bend would be proportional to the expected elongation of the material welded. In the standard bend test, the types of failures usually encountered are shown in Fig. 3.

It will be noted in Table 5 that little difference was observed in the root bend tests with various types of weld rod combinations. Variation in the face bend results were obtained. Although the E6010-E6010-E6010 rod combination resulted in satisfactory bends, the weld yield strength and elongation were low and all tests broke in the weld. Whenever more than one bead of E6010 rod was used, the weld tensile test elongation was generally low. It is interesting to note that whenever a high strength rod is used in either the first or second beads and covered with a soft E6010 rod, the face bend tests were generally poor. For these reasons, a higher strength rod than E6010 was used for the grade of steel under investigation.

● **Influence of chemistry on girth welds.** A number of girth welds made in accordance with the procedure described in Fig. 1 were examined in order to evaluate the influence of chemistry on the structure and properties of the welded pipe joint. The bend and tensile test results are shown in Table 6. It will be noted that the bend tests in ordinary line pipe, Code C (Grade B- 20-in. OD by 0.312-in. wall) were 180 deg.

The results with relatively high strength rods E10010 or E8011 in all three beads were slightly superior to the use of an E7010 rod for the root bead, followed by two beads of either E10010 or E8011 rods. These combinations appeared to be preferable to the use of E7010 rods for all three beads.

In addition to the bend test results, it is significant to observe the tensile test results. The tensile test fractures of those weld rod combinations that showed improvement in the bend test were usually located in the unaffected base plate. With the use of a high strength weld rod combination and excess weld metal in the face bead, the tensile properties of welded high yield strength line pipe, with the exception of the elongation, should be essentially dependent upon the strength of the base plate material.

The hardness survey made in accordance with the procedure described in Fig. 2 and microstructure of several high yield strength welds are shown in Table 7. It will be noted that the maximum diamond pyramid hardness (10 kg load) of the heat-affected zone was 357 and the maximum diamond pyramid hardness (0.5 kg load) of the same zone was 452 in the high chemistry weld.

TABLE 5. Effect of various welding rod combinations on bend and tensile tests of 0.36-0.39 per cent C, 1.24-1.28 per cent Mn steel.

Type of weld rod			Root bend angle*	Face bend angle*	Weld tensile tests		
Root	Filler	Face			Yield 1000 psi	Ultimate 1000 psi	Per cent elongation in 2 in.
U	U	U	180°	180° (b)	63	89	9
X	U	U	180°	115°	74	89	9
U	X	U	180°	90°	72	97	17
Z	X	U	180°	70° (a)	75	102	17
X	X	X	180°	180° (b)	73	97	15
U	X	X	165°	130°	70	100	17
X	U	X	180°	170° (b)	71	94	21
U	U	X	180°	165°	70	84	8
V_2	V_2	V_2	180°	85°	72	93	21
W	W	W	180°	170° (b)	73	95	18
V_3	V_3	V_3	180° (b)	150°	62	88	16
V_2	X	X	180°	165°	72	98	16
V_3	W	W	170°	160°	65	95	16
V_1	X	X	180°	170°	76	95	16

*All results represent an average of three tests except (a) 1 test, and (b) 2 tests
Rod Type: U-E6010, V_1-E7C1C, V_2-E7010, V_3-E7C10, W-E8011, X-E10010.

TABLE 6. Influence of chemistry on tensile and bend tests.

Code no.	C	Mn	Weld rod* combination	No. tests each group	Face bend angle	Root bend angle	Weld tensile tests		
							Yield 1000 psi	Ultimate 1000 psi	Per cent elongation in 2 in.
C	0.22	0.47	U-U-U	6	180°	180°	46	66	29
A	0.37	1.27	V_1-X-X	6	165°	180°	74	98	19
B	0.38	1.42	V_1-X-X	5	149°	180°	90	105	16

*Welding Rods: U-E6C10, V_1-E7010, X-E10010.

TABLE 7. Influence of chemistry on hardness and microstructure.

Code no.	C	Mn	No. of tests	DPH hardness				Microstructure
				Unaffected base metal maximum 10 kg load	Heat affected zone max. 1 kg load	Weld metal maximum 10 kg load	Heat affected zone max. 0.5 kg load	
A	0.35	1.26	8	207	266	210	258	Pearlite, bainite and ferrite without any martensite
B	0.38	1.42	4	223	357	230	452	2 to 20 per cent martensite

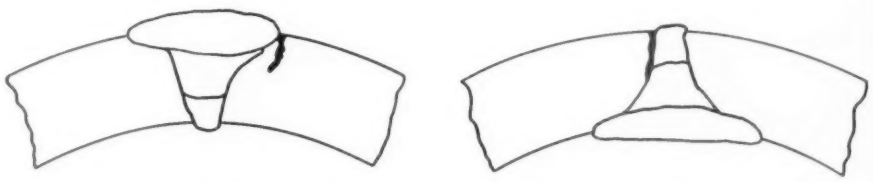

FIG. 3. Typical failures in bend tests.

Taken from the article, "Metallurgical properties of high yield strength seamless line pipe," by A. B. Wilder1 and J. D. Tyson2 that was presented before the American Welding Society Chicago, Illinois, October 18-24 and published in *Welding Journal*, and published in *The Petroleum Engineer*, February, 1948, pages 138 to 152, inclusive.

1. Chief Metallurgist, National Tube Company.
2. Chief Metallurgist, Lorain (Ohio) Works, National Tube Company, subsidiary of United States Steel Corporation.

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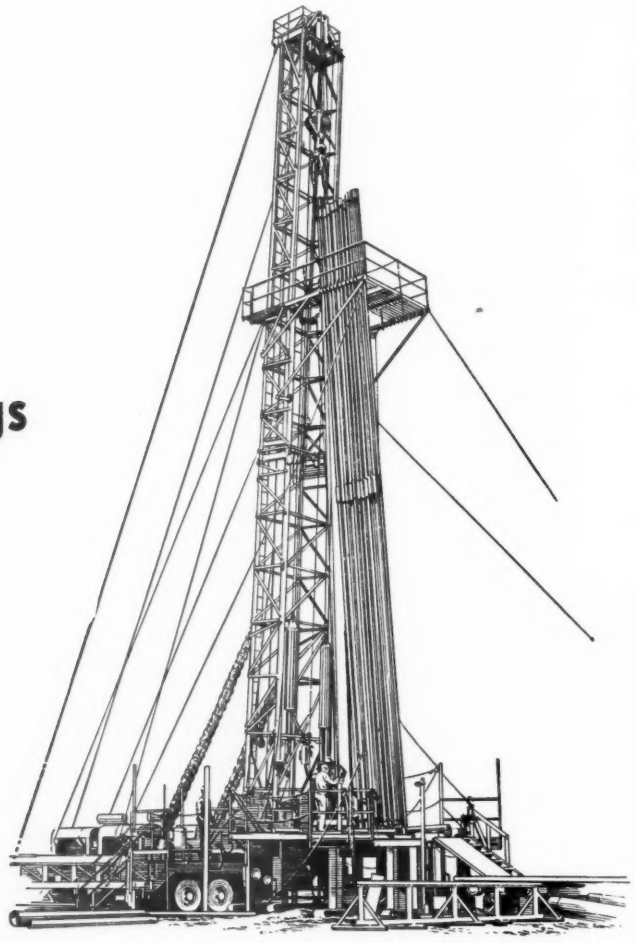

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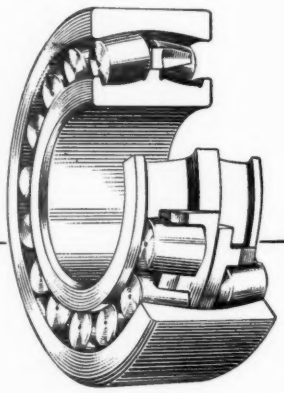

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PROPERTIES OF HIGH YIELD STRENGTH SEAMLESS PIPE

In Fig. 7, the nature of cracks observed in the X-ray tests are shown. In addition, the nature of occurrence of slag pockets or "car tracks" is shown. Cracks observed in these high yield strength welds are associated with welding technique.

The crack shown in Fig. 7b was associated with poor welding technique and was due to lack of penetration in the root bead. The crack shown in Fig. 7c was also due to poor welding technique, originating at the root bead. In Fig. 7d the crack is associated with a tack weld and would not occur in pipe not tack welded. The results of the X-ray tests indicate the importance of good welding technique, which applies not only to high yield strength line pipe, but also to ordinary line pipe. The precautions to be observed in welding ordinary line pipe are not as important compared to high yield strength line pipe.

● **Influence of chemistry in bead welds.** The bead welds were made in accordance with the procedure already described and illustrated in Fig. 1. A 0.5 kg load was used in hardness testing. The hardness and microstructure in Table 8 are from weld beads deposited with a 5/32-in. rod and 17-in. per min travel speed. This type of weld bead involves extremely fast cooling rates and should be used only for a comparison of various types of steel and not directly with girth weld test results.

Although carbon is usually associated with the hardness of welds, it will be noted in Table 7 that manganese is also a factor. In steel containing 0.30-0.32 per cent C an increase from 1.12 to 1.35 per cent manganese resulted in an increase in maximum hardness. Similar results were obtained with steel containing 0.36-0.37 per cent C; however, with 0.40-0.41 per cent C material, an increase from 1.16 to 1.42 per cent manganese did not appreciably change the maximum hardness obtained due to the high carbon content of the material. These results indicate that under certain conditions, it may be more desirable to increase the carbon content in preference to manganese in order to obtain higher yield strength material. A closer relationship to the conditions encountered in girth welds will be obtained when results from tests being conducted with a 3/16-in. rod and 9-in. per min travel speed are available. In line pipe welding, carbon has usually been considered the most important factor with respect to the maximum hardness obtained in the weld. These results indicate that under certain conditions manganese may be the controlling factor.

● **Summary.** 1. Various factors relating to the bend tests in high yield strength line pipe were investigated. Removal by grinding of the mechanical notch effect of the outside bead improved the ductility of the welded joint as measured by the bend test.

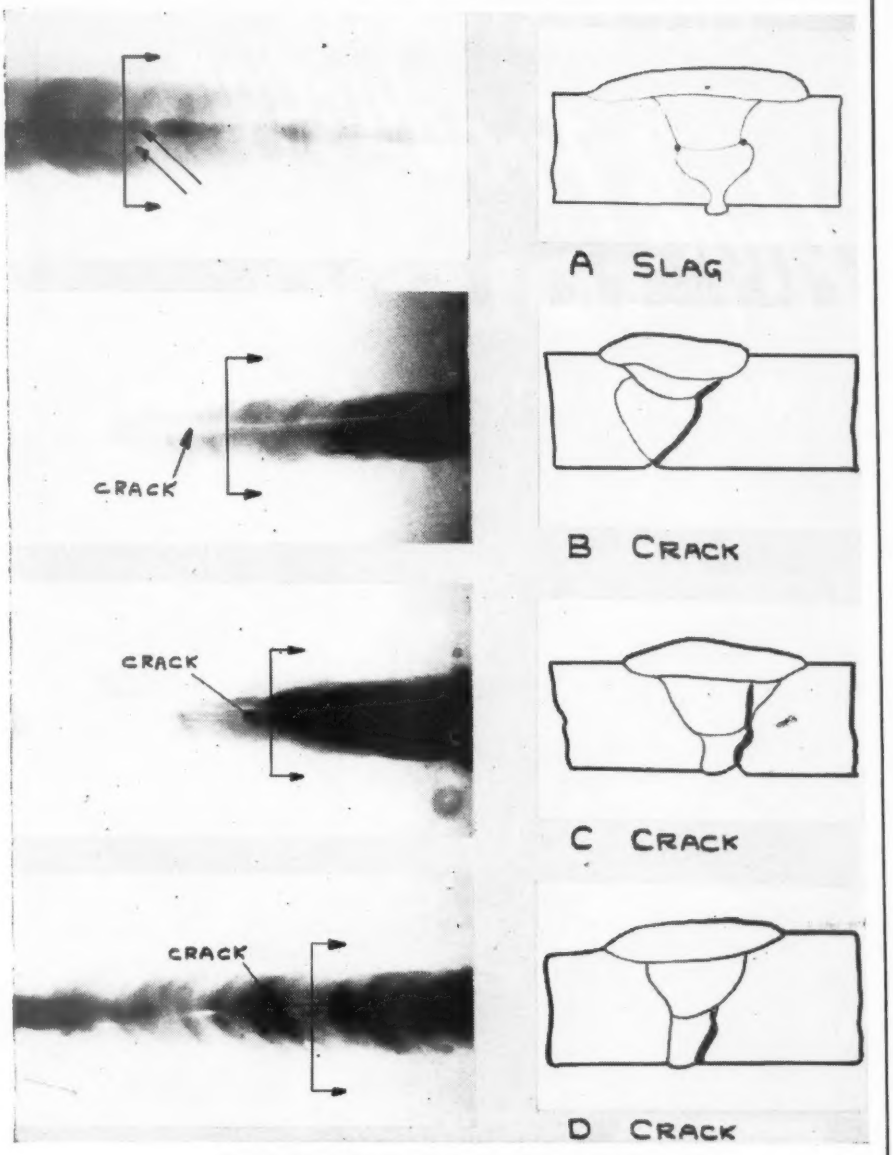

FIG. 7. Nature of cracks in X-ray examination.

2. Various types of weld rod combinations and their influence on the physical properties of the welded joint were investigated. High strength weld rod combinations involving Types E7010, E8011, and E10010 electrodes produced the best results for high yield strength line pipe.

3. The influence of chemical composition of pipe material on the physical properties of welds in high yield strength line pipe was evaluated, and the relationship of carbon and manganese developed. A minimum yield strength of 52,000 psi and minimum tensile strength of 75,000 psi were obtained with open hearth steel pipe containing 0.40 per cent max carbon and 1.40 per cent max manganese.

4. Results with X-ray analysis of girth welds in high yield strength line pipe indicated the importance of proper welding technique.

TABLE 8. Influence of chemistry on bead welds.

Code	C	Mn	Max. hardness* DPH	Microstructure at max. hardness
D	0.30	1.12	426	M—90 per cent
E	0.31	1.26	499	M—90 per cent
H	0.32	1.35	534	M—99 per cent
F	0.36	1.14	407	M—85 per cent
G	0.37	1.36	508	M—90 per cent
I	0.37	1.37	553	M—99 per cent
J	0.41	1.16	572	M—95 per cent
K	0.40	1.34	627	M—99 per cent
L	0.40	1.42	583	M—99 per cent

*0.5 kg load.

Taken from the article, "Metallurgical properties of high yield strength seamless line pipe," by A. B. Wilder1 and J. D. Tyson2 that was presented before the American Welding Society Chicago, Illinois, October 18-24 and published in *Welding Journal*, and published in *The Petroleum Engineer*, February, 1948, pages 138 to 152, inclusive.

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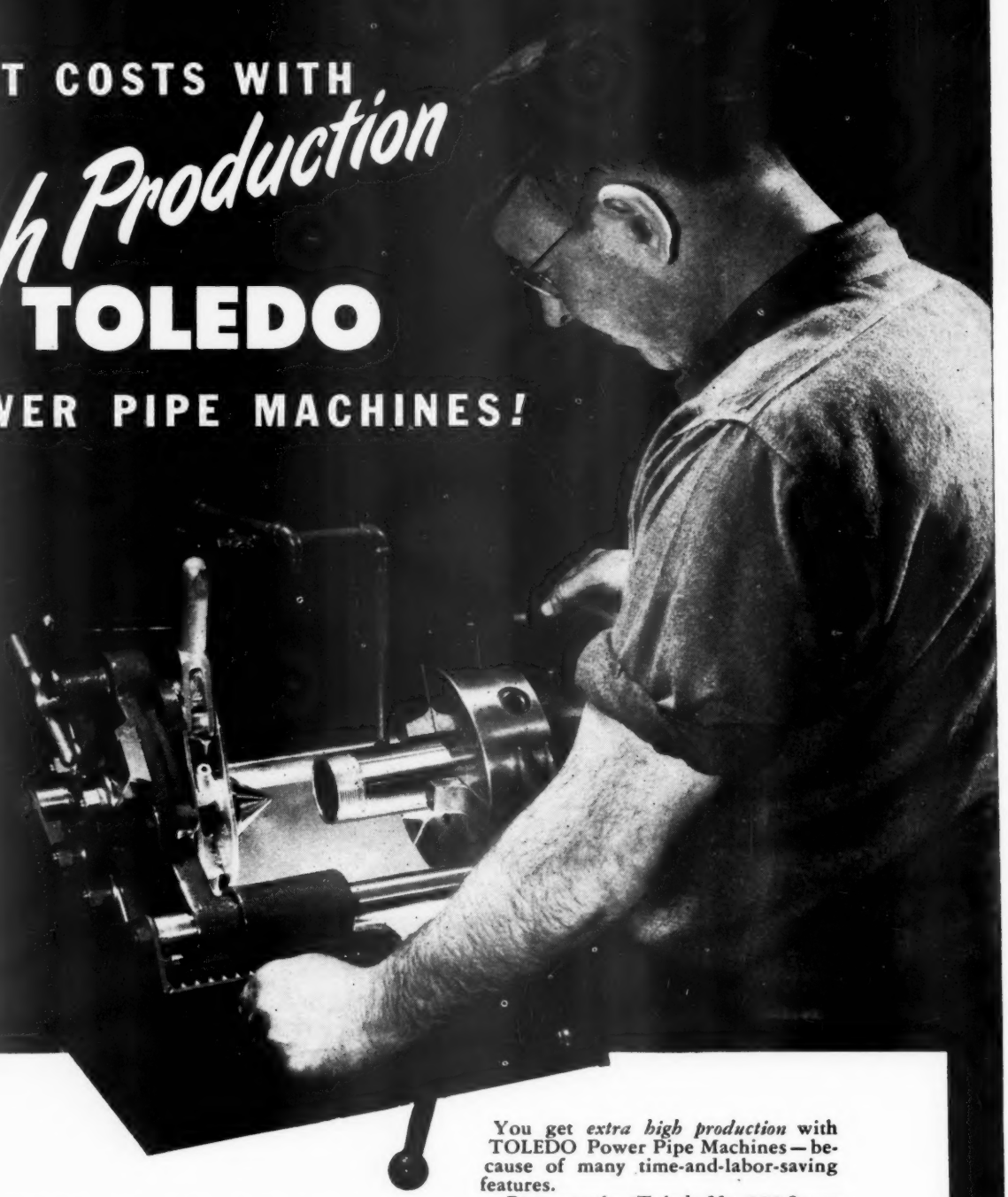

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CONTROL OF NARROW BOILING RANGE FRACTIONATING COLUMNS

PRESENT day petroleum refining practices are working toward a higher and higher degree of separation of the narrow boiling range hydrocarbons; hence more accurate and more direct methods of instrumentation and control are required.

Fig. 1 shows a deisobutanizing column that fractionates isobutane from normal butane.

At 110 psi column pressure, there is only 23 F difference between the boiling point of pure isobutane and that of pure normal butane. On this basis a change of only 1.0 F in column temperature will cause a change in composition of approximately 4 per cent. The product overhead may also vary in the order of 2 to 3 per cent with a change in pressure as small as 1.0 psi. Changes in barometric pressure alone can be responsible for variations of several per cent in the purity of the overhead material. From this it can be seen that it is important to maintain *both* pressure and temperature within very close limits.

One method that has been developed for controlling such narrow boiling range columns is commonly known as a vapor pressure controller, although on strictly *binary* columns it is essentially a *composition controller*. This instrument consists of a temperature bulb and pressure connection, both being situated at the same point in the column (Figs. 2 and 3). The temperature bulb is partly filled with one of the materials being fractionated. This bulb when exposed to the column temperature will exert a vapor pressure against one side of the diaphragm or mercury U tube, the other side of which is opposed by the pressure of the column taken at the same point that the temperature sensitive bulb is situated. Whenever the material at this point in the column is of the same composition of that in the bulb, no differential on the instrument will exist regardless of what pressure or temperature elevation is encountered. Conversely, by holding a zero differential pressure on the vapor pressure controller the composition on the tray will always be the same as that in the bulb Composition vs. column pressure curves indicate . . .

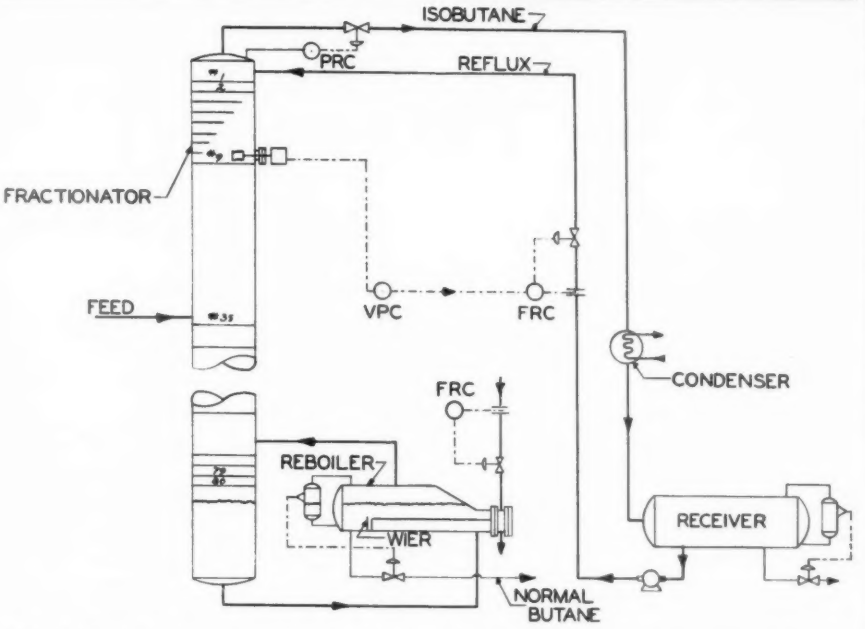


FIG. 1. Deisobutanizing column that fractionates isobutane from normal butane.

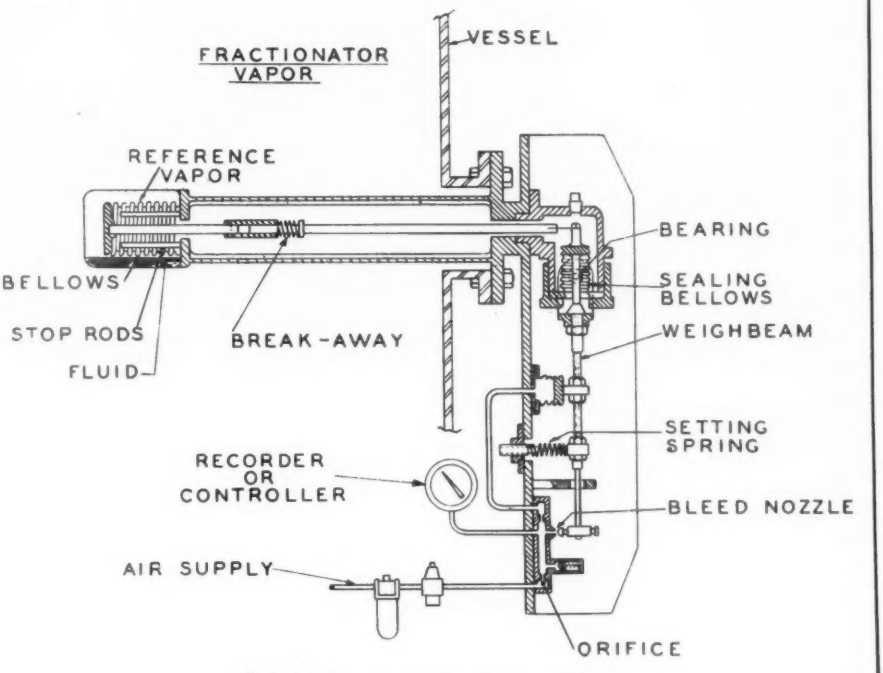
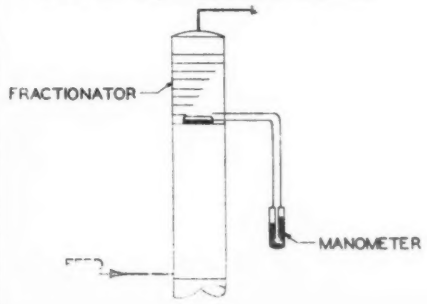


FIG. 3. A vapor pressure transmitter.

FIG. 2. Vapor pressure balance.

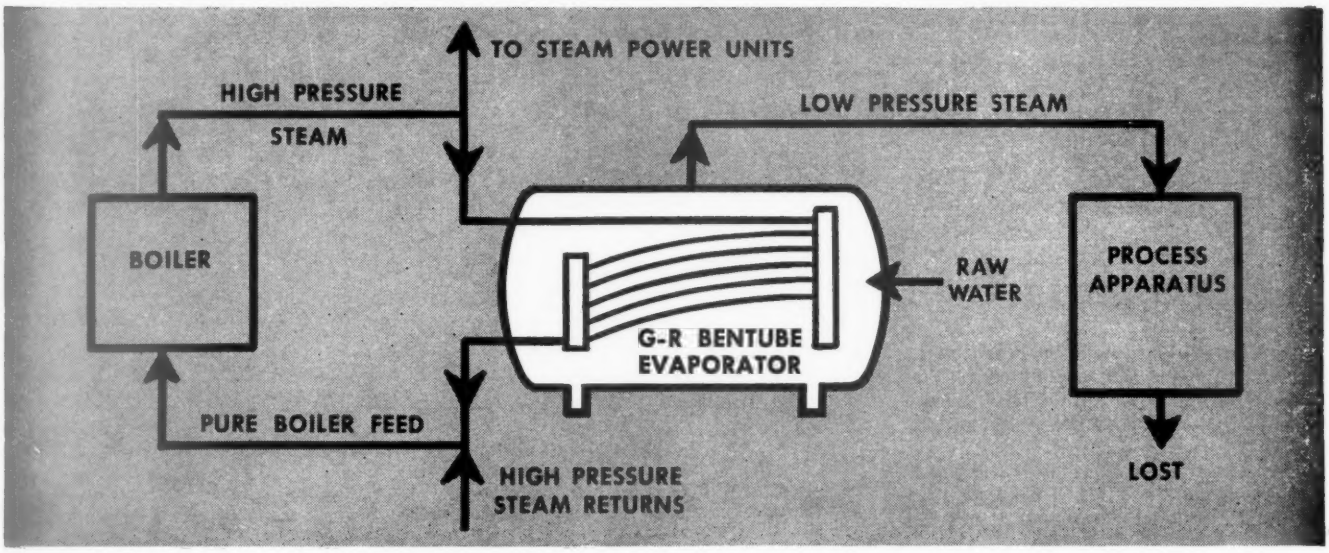


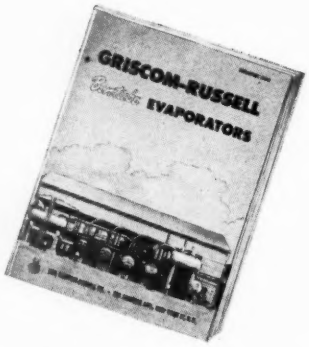
that with a constant differential on the vapor pressure controller there is very little change in composition even with wide changes in column pressure. In other words, with a 1.0 psi change in column pressure, the composition will only change 0.4 per cent instead of the 2 to 3 per cent encountered when using a temperature controller and assuming it holds the temperature perfect.

Although this method of control is satisfactory for binary columns, its use in columns of multi-component mixtures is somewhat limited and the limitations have not as yet been fully explored.

Taken from the article by G. G. Gallagher of Universal Oil Products Co., that was presented before the Chicago Section of the Instrument Society of America, February 3, 1947, and published in *The Petroleum Engineer*, March, 1948, pages 82 to 84, inclusive.

HOW you can obtain PROCESS STEAM efficiently.





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FACTORS IN THE SELECTION AND USE OF SUCKER ROD PUMPS

● **Double valves.** Fig. 6 shows various arrangments of double valves for traveling and standing valves.

There has been considerable discussion concerning the desirability of two balls and seats in series and it has been argued that the load cannot distribute itself between the two valves, and only one will form a tight seal on any particular stroke. This line of reasoning has led to the conclusion that two valves in series cannot be of any particular advantage. Experience has shown, however, that two valves in series will give much longer service than a single valve if the valve life is determined by wear, or fluid cutting, rather than by corrosive action. This result appears entirely logical where sand or other solid material is lifted with the oil. In such cases failure is likely to occur as a result of fluid cutting when a solid particle is caught between the ball and seat and prevents perfect seating. A pressure differential of 2000 psi will produce a jet of fluid having a velocity of over 500 fps and such a fluid velocity can easily damage the lapped valve seating surface on balls and seats in a short time, especially if the fluid jet carries solid material in suspension.

The life of a ball and seat will depend largely on the number of times it is subjected to the action of such fluid jets, and this can be decreased greatly by the use of double valves, inasmuch as a jet cannot occur until both balls are held off their seats during the same stroke. For example, if conditions are such that a single ball and seat is prevented from seating properly one out of each 100 strokes, on the average, the chances of both of two valves in series failing to seat properly will be reduced to 1 in 10,000 strokes.

The only apparent objection to double valves is the possibility of affecting pump efficiency by the slight added pressure drop at the pump inlet, when pumping highly volatile and gassy fluids, especially when it is necessary to pump the well down to a low fluid level to produce its allowable. Any influence on production can be determined by making alternate runs with single and double standing valves.

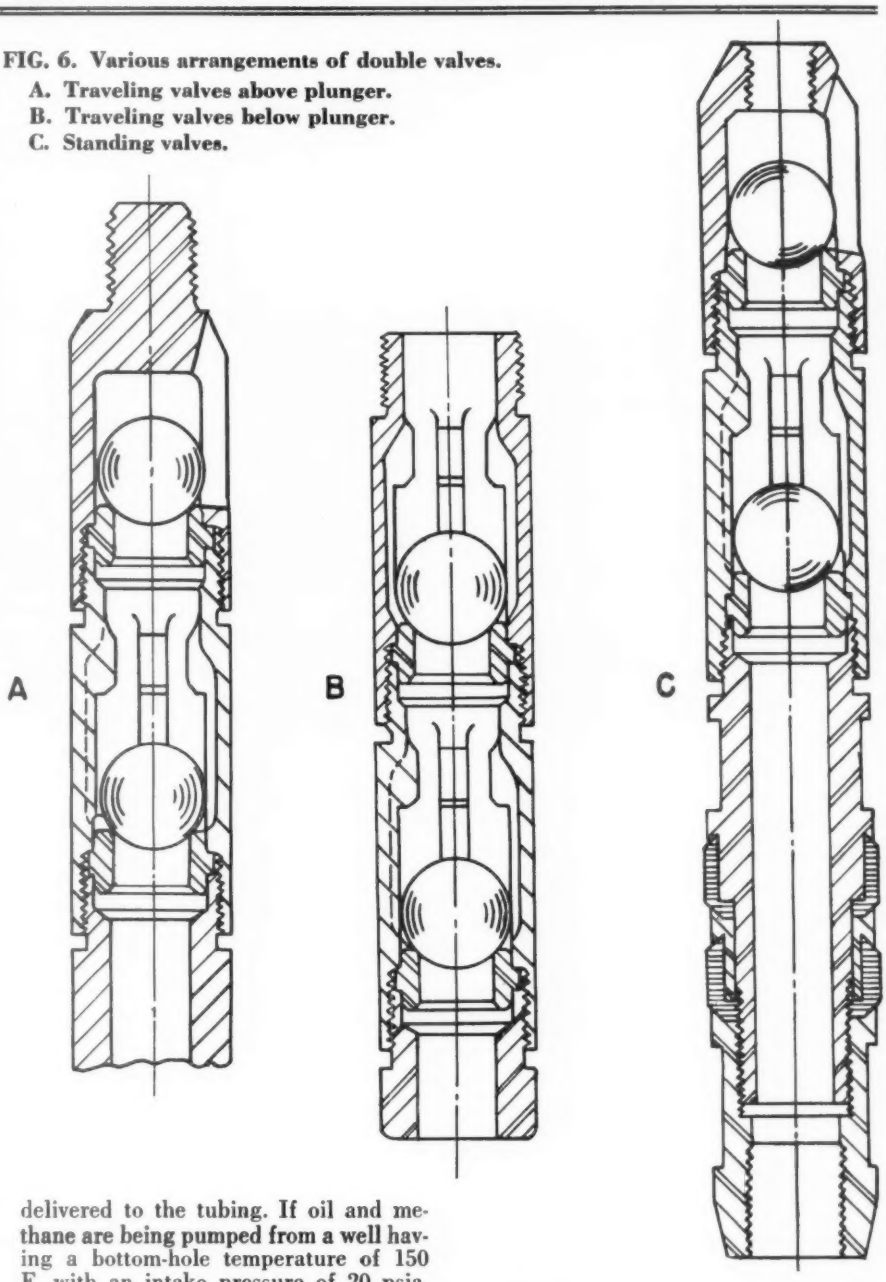
Aside from the selection of most suitable materials, it is suggested that consideration be given to the possibility of reducing corrosion by reducing maximum temperatures. The compression of gas within the pump barrel can result in very high temperatures, and a rise in temperature always greatly increases the speed of a chemical reaction. As a rough approximation the chemist Ostwald estimated that the speed of a chemical reaction was about doubled for each 10 C (18 F) rise in temperature.

In pumping a well with a pressure of 2000 psig at the pump, any gas collected in the pump barrel must be compressed to this value before any fluid can be delivered to the tubing. If oil and methane are being pumped from a well having a bottom-hole temperature of 150 F, with an intake pressure of 20 psia, the temperature of the methane can rise to a value above 1300 F as a result of adiabatic compression, with this compression ratio of over 100 to 1 in a single stage. Still higher temperatures can result from higher discharge pressures, lower intake pressures, higher bottom-hole temperatures, or any combination of these factors. For methane, which is the major constituent of most natural gas, the ratio of specific heat at constant pressure to specific heat at constant volume:

$$\frac{C_p}{C_v} = k = 1.316 \quad \text{and}$$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} = \left(\frac{P_2}{P_1}\right)^{0.24} \qquad (2)$$

FIG. 6. Various arrangements of double valves.
A. Traveling valves above plunger.
B. Traveling valves below plunger.
C. Standing valves.

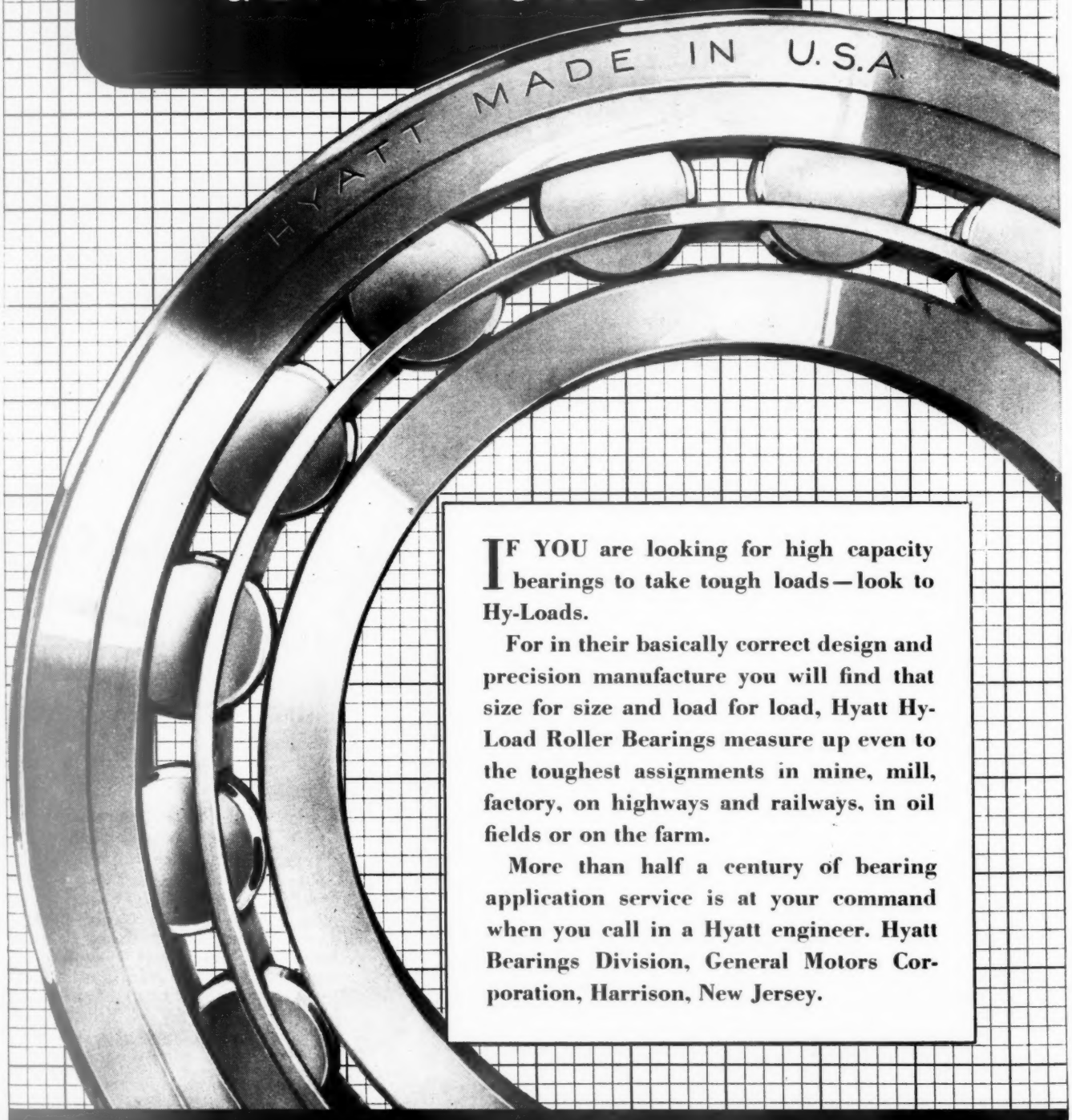


Where:
T_1 = initial absolute temperature,
T_2 = final absolute temperature,
P_1 = initial absolute pressure,
P_2 = final absolute pressure.

From this relation, and knowledge of inlet pressure, discharge pressures, and bottom hole temperatures, the maximum temperature obtainable by adiabatic compression can be calculated. Actual temperatures probably are considerably lower because of the cooling action of a relatively small bore pump surrounded by oil.

Taken from the article "Factors to be considered in the selection of subsurface sucker-rod pumps," by R. L. Chenault, presented before The American Society of Mechanical Engineers, Houston, Texas, October 5-8, 1947, and published in *The Petroleum Engineer*, January, 1948, pages 132 to 150, inclusive.

FOR TOUGH LOADS GET HY-LOADS



IF YOU are looking for high capacity bearings to take tough loads—look to Hy-Loads.

For in their basically correct design and precision manufacture you will find that size for size and load for load, Hyatt Hy-Load Roller Bearings measure up even to the toughest assignments in mine, mill, factory, on highways and railways, in oil fields or on the farm.

More than half a century of bearing application service is at your command when you call in a Hyatt engineer. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

ARCH L. FOSTER JOINS THE PE EDITORIAL STAFF

Arch L. Foster, well known in the petroleum and automotive industries as author, researcher, and inventor, has joined the staff of *The Petroleum Engineer* as editor of refining and gas processing. He was formerly refining editor of the *Oil and Gas Journal*, with offices in New York. He has been connected with the publication since 1942.

Foster was born and educated in Texas. He received both his bachelor and master degrees from the University of Texas in 1921-22, where he studied organic chemistry and chemical engineering under Dr. J. R. Bailey and Dr. E. P. Schoch.

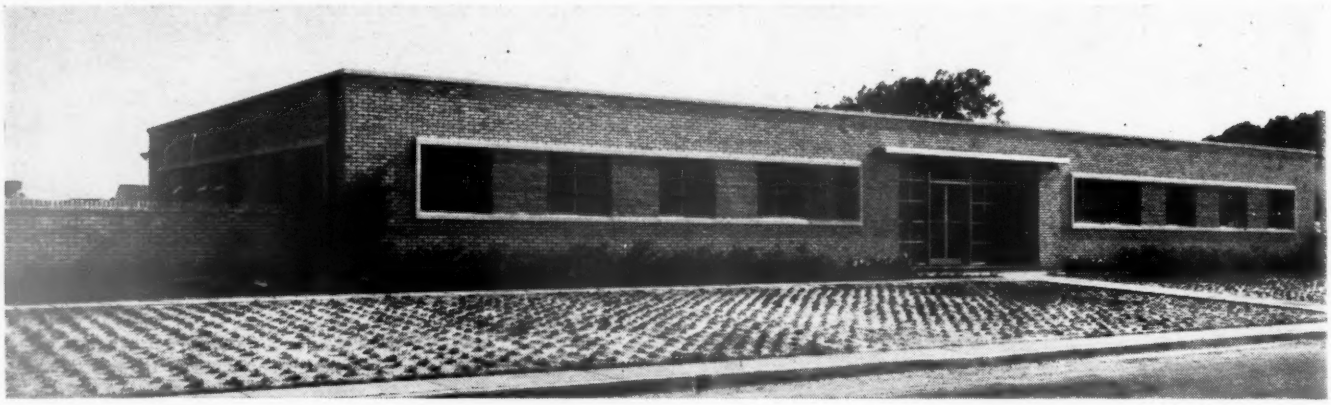
Joining the Gulf Refining Company at Port Arthur, Texas, in 1922, he did research on thermal cracking, catalytic (aluminum chloride) cracking, with Dr. A. M. McAfee. Three years later he left to go into the Petroleum and Natural Gas Division of the U. S. Bureau of Mines where he did research on qualities and performance of fuels and lubricants and, with Gustav Wade, automotive engineer of the Bureau, he did experimental work on engine operations. He had been assistant on refining to the chief engineer of the division for a year when he resigned in 1929. From 1929 to 1939 Foster was technical editor of the *National Petroleum News*. Before he joined the *Oil and Gas Journal* he spent two years in the research and patent departments of Phillips Petroleum Company. He has some 20 patents on petroleum processing.

Foster is active in several societies: American Chemical Society, Society of Automotive Engineers, Institute of Chemical Engineers, and was chairman of Mid-Continent section of the SAE in 1946.

An accomplished writer, Foster is the author of a large number of papers and articles on various phases of petroleum refining and has had an elementary textbook on petroleum chemistry published.

Foster comes to *The Petroleum Engineer* with a broad background of actual experience and technical writing, which should serve well the large number of readers who must keep abreast of the rapidly moving advances in the refining and gas processing divisions of the petroleum industry.

Delta Engineering Corporation in new office building



Delta Engineering Corporation recently moved into its new office building at 2121 San Felipe Road, Houston, Texas.

The new building is of modern American architecture, functionally designed to meet the company's specific requirements. The entire structure, comprising an area of approximately 6000 sq ft, is provided with year around air conditioning. Construction is of structural and masonry throughout with an exterior finish of Mexican handmade brick and Colorado limestone. The basic structure is designed to accommodate a second floor to provide for expansion.

Delta Engineering Corporation is engaged in the design and construction of natural gas processing facilities for the oil and gas industry. Installations of natural gasoline recovery, pressure maintenance and gas dehydration plants have been completed, or are under construction, for large independents, major unit operators, and major oil companies throughout the southwest.

Officers of the corporation are Robert B. Baldwin, president; George L. Gudenrath and Allen R. Salley, vice presidents, and W. J. Geiselman, secretary-treasurer.

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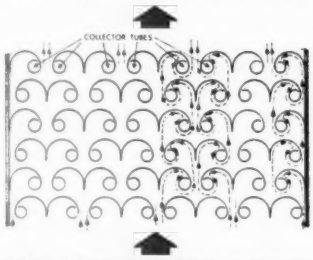
gives you *truly* dry gas or steam

EXHAUST

DRY GAS OR LIVE STEAM



WET GAS OR STEAM INLET

New baffle principle completely knocks out *all* liquid and mist from *any gas or steam.* Exceptionally *high capacity.* Write for complete, descriptive MIS-D-FIER Bulletin.

J. A. CAMPBELL CO.

645 E. Wardlow Road

LONG BEACH 7, CALIF.

H. B. Hill retires

Harry B. Hill, petroleum engineer of the Bureau of Mines and supervisor of the Dallas, Texas, field office for the last 24 years, has retired after three decades of government service, James Boyd, Bureau director, announces.

H. B. Hill

Chas. B. Carpenter

A native of Ohio, Hill joined the Bureau of Mines in 1918 at Muskogee, Oklahoma, and served for a time at Salt Creek, Wyoming, and Washington, D. C. He became supervising engineer of the Dallas office in 1924. At the time of his retirement on July 1, he was 64 years old.

Charles B. Carpenter, petroleum engineer closely associated with Hill at the Dallas field office since he joined the Bureau of Mines 20 years ago, has been promoted to the position of supervising engineer.

Because of his intimate knowledge of oil and gas fields in Texas, Oklahoma, and Louisiana—acquired through years of directing petroleum engineering studies—Hill's services were constantly in demand, both inside and out of the government.

Carpenter, the new supervising engineer, completes 20 years' continuous service at the Dallas field office in November. He was appointed assistant petroleum engineer in November, 1928, and successively has held petroleum engineering positions of increasing responsibility. In addition to many important petroleum engineering studies by Carpenter reported in Bureau of Mines publications, he has been given many responsible special assignments, including a number on problems relating to petroleum supplies for war activities.

Bob Swanson dies

Harry R. (Bob) Swanson, founder and president of Petro-Chem Development Company, died July 24. Born 48 years ago, Swanson identified himself with the petroleum refining industry almost immediately after receiving his chemical engineering degree from MIT. He received his B.S. degree from Hobart College. With the Atlantic Refining Company, Foster Wheeler, American Locomotive Company, and as head of Petro-Chem Development Company, his work in developing the art of petroleum refining made him hosts of friends.

Dr. Dow honored

The American Society of Metals announces that Willard H. Dow has been elected to receive the Society's Medal for the Advancement of Research for 1948. Dr. Dow is president of the Dow Chemical Company, Midland, Michigan.

Qualifications for the candidate who receives this award do not specify that any one research achievement shall be the basis for awarding the honor. W. H. Eisenman, National Secretary of ASM, stated that "rather the candidate shall be an executive in an industrial organization, the principal activity of which is the production or the fabrication of metals. He shall be one, who, over a period of years, has consistently sponsored metallurgical research or development, and, by his foresight and his influence in making available financial support, has helped substantially to advance the arts and sciences related to metals."

Presentation of the medal, plaque and citation will be made at the annual banquet of the American Society for Metals to be held in Philadelphia on October 28 during the National Metal Congress and Exposition, principal international event of the metals industries.

CRUDE, CRACKED AND VOLATILE

Blessings on thee, little man,
Barefoot boy with cheek of tan;
Trudging down a dusty lane
With no thought of future pain;
You're our one and only bet
To absorb the national debt.

Little man with cares so few,
We've got a lot of faith in you;
Guard each merry whistled tune,
You are apt to need it soon,
Have your fun now while you can;
You may be a barefoot man.

* * *

Employer: For this job we want a responsible man.

Applicant: Then, that's me. Everywhere I've worked when something went wrong I was responsible.

* * *

The teacher attached this note to little Johnny's report card:

"Dear Mrs. Ostrom: Johnny is a bright boy, but he spends all his time with the girls. I'm trying to think up some way to cure him."

Mrs. Ostrom studied the note, then wrote the teacher: "If you think of a way to cure Johnny, let me know. I haven't been able to cure his father."

* * *

Sweet Young Thing: I've been misbehaving and my conscience is bothering me.

Psychiatrist: Well, I can help you strengthen your will power.

Sweet Young Thing: Er—could you give me something to weaken my conscience?

* * *

Extract from a patent medicine testimonial: "Since taking your tablets regularly, I am another woman. Needless to say, my husband is delighted."

* * *

She: Does your husband still find you entertaining?"

Her: Not if I can help it.

* * *

Wife: I think married men should wear something to show that they're married."

Hubby: I do! Look at this shiny suit!

* * *

Perfume salesgirl to blonde: "Just a word of advice. Don't use this stuff if you're only bluffing."

* * *

Woman: Son, can you direct me to the savings bank?

Boy: Yessum, for a quarter.

Woman: Isn't that mighty high, my boy?

Boy: Not for a bank director, missus.

* * *

She: How did you like the bridge party last night?

He: It was fine until the cops looked under the bridge.

A bigamist is a man who has taken one too many.

* * *

They laid him out on the station house floor, and the doctor examined him, while the cop who had brought him in stood by. The doctor finished and rose. "That man's been drugged." The cop went white and shivered. He said: "That's right, sir. It's my fault. I drug him six blocks."

* * *

Mo: Did you hear about the chap who stayed up all night figuring out where the sun went when it went down?

Bo: No, what happened?

Mo: It finally dawned on him.

* * *

Judge: On what grounds are you applying for a divorce?

Mr. Brown: Extravagance, your Honor.

Judge: Extravagance, how's that?

Mr. Brown: She kept on buying ice after I had installed an electric refrigerator.

* * *

"This pen leaks," said the convict, as the rain came through the roof.

* * *

Gert: And then he and I talked about the weather.

Flirt: About the weather?

Gert: Yeah, whether to, or whether not to.

* * *

Joe was dead, and Elmer called on the widow to express his sympathy. "Joe and I were mighty close friends," Elmer said. "Isn't there something I could have to remember him by?" Tearfully she raised her eyes and whispered softly, "Would I do?"

* * *

An economist is a man who has a Phi Beta Kappa key on one end of his watch chain and no watch on the other.

* * *

My wife and I our costumes choose
Of similar styles and stocks;
Milady wears the toeless shoes,
And I the toeless socks.

* * *

This year's bathing suits will be barely big enough to keep a girl from being tanned where she ought to be.

* * *

"Miss Jones, I may say that you are a very attractive girl. You dress well, your voice is well modulated, your deportment is also beyond reproach . . ."

"Really," exclaimed the new secretary, blushing. "You shouldn't pay me so many compliments!"

"Oh, that's all right. Now, about the matter of punctuation and spelling."

* * *

The young husband came home from the office. "What's the matter, dear?" he asked his young wife. "You look upset."

"Oh, it's been a dreadful day," his wife said. "First the baby cut his first tooth, then he took his first step, and then he fell and knocked out his tooth."

"Well, then what happened?" asked the young pop.

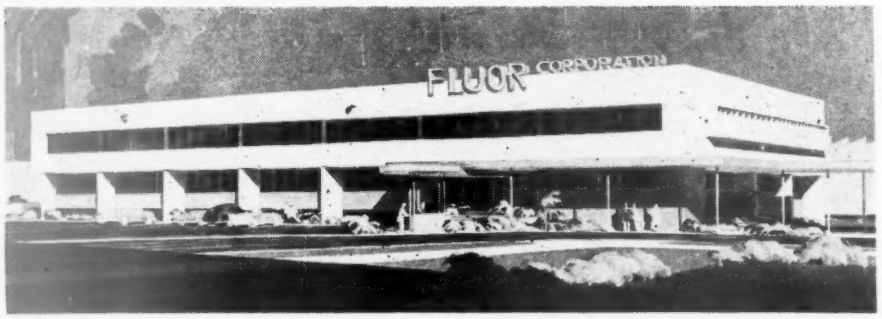
"Then, darling," cried the young wife unhappily, "then he said his first word!"

* * *

A man about to be electrocuted phoned his lawyer from the death chamber. "They are about to put me in the electric chair," he said. "You are my lawyer—what do I do now?" The lawyer answered helpfully, 'Don't sit down."

...AND ON THE WAY HOME, STOP AND GET ME A COUPLE OF THOSE LANE-WELLS DOVE-TAILED SLIPS! IT SAYS HERE THEY NEVER CATCH OR GET WRENCHED OUT OF SHAPE!
LANE WELLS PACKERS
HUBENTHAL

Fluor to add large engineering building



In the new Los Angeles engineering building of The Fluor Corporation, Ltd., the top floor alone will house more than 200 draftsmen. Believed to be one of the most advanced engineering buildings designed in recent years, with about 62,000 sq ft of floor space, it has such modern innovations as an overhanging second floor, a four-wing floor plan, continuous window areas, and aluminum window louvres for light control. The basement will contain a garage, storage, and blueprint facilities—complete with dumbwaiter print service to upper floors. Project engineers and their staffs will occupy the first floor.

The new building will be an addition to Fluor's main plant and home office, at 2500 South Atlantic, Los Angeles, and will permit the unification of the company's Los Angeles staff, which had overflowed into two office buildings.

Export office changes

Announcement has been made from Dallas headquarters by G. W. Walton, vice president, machinery and export sales, of changes in personnel in the New York export office of International Derrick and Equipment Company.

A. L. Woracek has been appointed export manager of sales of steel buildings, derricks, towers, and machinery. Woracek has been with Ideco for 23 years and has been associated with all phases of export operations. He has made a number of trips to South American oil fields and is credited with the development of tropical camp buildings now in use by major companies in many tropical operations. He is a member of the New York Chapter of Nomads.

B. V. Brown is now in the New York export office and will act as export manager of sales of machinery and supplies. Brown was formerly manager of purchases and stock control of Ideco's supply store division in Dallas and has a broad knowledge of oil field operations. He has had 20 years' experience in sales and purchasing with manufacturers and suppliers of equipment and was formerly connected with Frick Reed and Bridgeport Machine and Tool Company. Brown is a member of Nomads New York Chapter.

James E. McGuire, who for the last two years has been buyer in Ideco's Dallas export office, has been transferred to New York. McGuire will fill the position of export purchasing agent and office manager in the New York office. McGuire has handled phases of export business for Ideco since 1941.

It takes heavy-duty stamina and all-weather dependability for an engine to keep plugging away, 24 hours a day, out in the open . . . as this Model VE-4 Wisconsin Air-Cooled Power Unit is doing. You'll find it on the job, any day, any hour, pumping an oil well in Central Oklahoma . . . for a concern that has a full appreciation of the value of heavy-duty design and construction, operating and maintenance economy, and weatherproof serviceability.

Incidentally, another point worth considering is the fact that this Wisconsin Engine is operating on natural gas.

For your power jobs between 2 and 30 hp., specify Wisconsin Air-Cooled Engines. You'll be glad you did if you do.

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
510 Atlas Building, Tulsa, Oklahoma
M & M Building, Houston, Texas
Oil field distributors for Wisconsin Engines and all types of utility units.

Pipe coating plant

A new industry—The Standard Pipeprotection, Inc.—has purchased a 20-acre site at 3000 South Brentwood Boulevard, St. Louis, Missouri, and within 90 days will begin construction there of a 70,000 sq ft plant. The plant will contain modern coating and wrapping equipment for the protection of small diameter steel pipe.

Geo. B. McComb

Cost of the plant will be approximately $500,000. In addition, the company will construct a modern office building fronting on Brentwood Boulevard, and establish its national headquarters there. President of the company is George B. McComb, Summit, New Jersey. Hugh W. Baird, Evanston, Ill., is vice president.

Both McComb and Baird formerly were associated with the Barrett Division of Allied Chemical and Dye Corporation, New York, McComb as general sales manager, and Baird as regional district manager in Chicago. John B. Wilson of Tenafly, New Jersey, former executive assistant to McComb at Allied Chemical, will be secretary-treasurer of the new company, McComb said.

Baker promotes

Baker Oil Tools, Inc., announces recent promotions in the central division as follows: R. D. McBrian, formerly West Texas district manager with headquarters in Odessa, has been transferred to central division headquarters in Houston as assistant division sales and service manager.

C. C. Tayler, formerly branch manager in Odessa, replaces R. D. McBrian as district manager for West Texas, with headquarters at Odessa. R. S. Bedillion, formerly branch manager at Victoria, has moved to Odessa as branch manager, C. A. Greve, formerly staff assistant at Houston, has been transferred to Victoria as branch manager. R. L. Ramby, formerly sales and service engineer in Corpus Christi, has been promoted to branch manager, with headquarters in Corpus Christi.

Cowart appointed

The Barrett Division. Allied Chemical and Dye Corporation, New York, New York, has announced the appointment of B. C. Cowart as manager of protective coatings sales to succeed G. B. McComb, resigned.

Classified

WANTED
PETROLEUM ENGINEER

To supervise the completion of rotary drilled wells. Must be thoroughly experienced in Mid-Continent and Gulf Coastal areas. Liberal salary for capable man. Correspondence confidential. Box 86, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

WANTED: Graduate Mechanical Engineer to supervise maintenance of deep well rotary drilling rigs. Must be thoroughly experienced and capable. Good salary. Give past record. Your letters held confidential. Box 87, c/o The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

WANTED
SALES ENGINEER

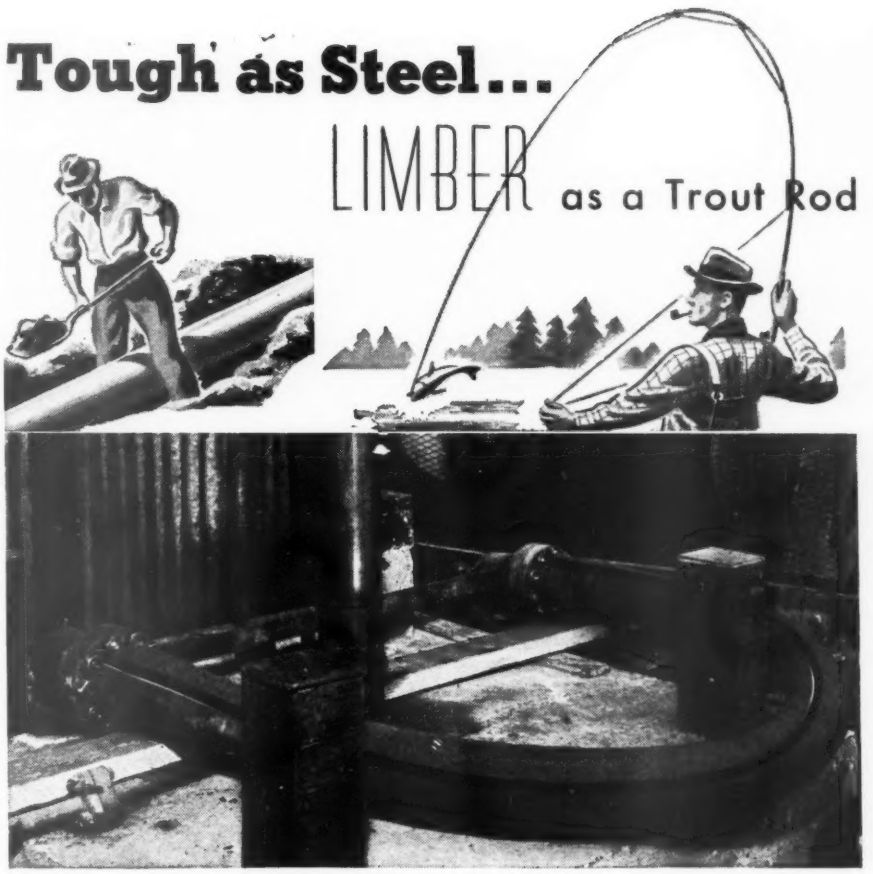
A manufacturer with national distribution needs a graduate engineer with refinery-contractor experience and a good understanding of oil refinery construction. Knowledge of piping highly desirable. Give personal, educational and experience details in first letter. Box 88, c/o The Petroleum Engineer, Box 1589, Dallas 1, Texas.

WANTED
CHEMICAL ENGINEER

Excellent opportunity for a Chemical Engineer with five or more years' experience in the petroleum field. Must be capable of handling complete process calculations. Write giving full particulars including professional and character references and salary expected. A photograph should accompany the application. Position is permanent. Address Box 82, c/o THE PETROLEUM ENGINEER, P. O. Box 1589, Dallas, Texas.

FOR SALE
DIESELS and PUMPS

Six new 1947 unused 475 BHP 5 cylinder Baldwin Model VG Diesel Engines, four connected to Ingersoll-Rand Multi-stage Centrifugal Pumps with Farrel-Birmingham Step-up Gears and two connected to Worthington Horizontal Triplex Double Acting Pumps, all units complete with Falk Couplings, Lummus Coolers, other accessories. Location Ohio, immediate delivery. Direct inquiries to The Buckeye Pipe Line Company, Joseph Steele, Purchasing Agent, Room 2200, 30 Broad Street, New York 4, N. Y.



Thermoid
Powerflex Rotary Hose
Reg. U. S. Pat. Off.

Take a look at the accelerated break-down test above. While bent into a sharp "U", this short length of Powerflex Rotary Hose is undergoing one of the most rugged tests imaginable—a pulsating load of 5000 pounds pressure!

Every length of Thermoid Powerflex Rotary Hose is tested to this same pressure. But this is only one of the many tests that Thermoid Powerflex Rotary Hose must pass under conditions far more severe than those ever encountered in normal operations.

The result is a hose that combines the strength of steel with remarkable flexibility—a hose that can take the pounding strain of long, continuous operation.

All Powerflex Rotary Hose is supplied with Pressure Seal, Full Flow, Built in Couplings.

Thermoid
Company

Main Offices and Factory · Trenton, N. J., U. S. A.
Western Offices and Factory · Nephi, Utah, U. S. A.
Industrial Rubber Products
Friction Materials · Oil Field Products

Petrolic Personalities

By DICK SNEDDON

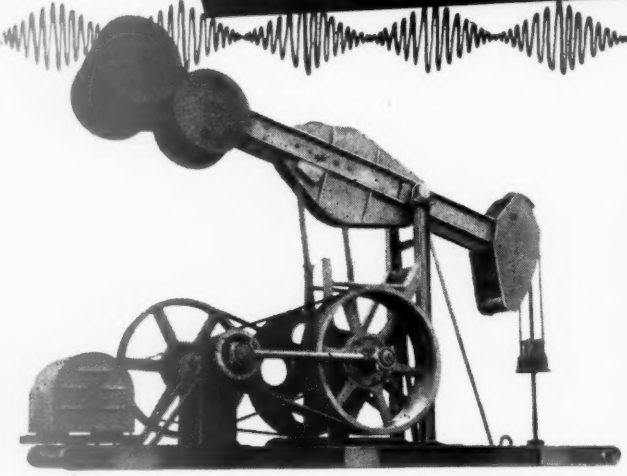
The Sairey Gamps of the oil business are legion! A few days ago we listened to a nomadic chappie (he had dined not wisely but wetly) holding forth in New Yorkese and with great excitement about a fight he once saw between "a pyton an' a boa constructor." It reminded us of a Scots lab boy we had once. He always called chromic acid "chronic", and conversely called a conical flask "comical." Then, of course, there was the dear old lady who lost her husband when his ship was sunk by a "sumbarine in the Idiotic Sea." All this and other bits of verbal mayhem we were discussing with Earl Cater, the Pittsburgh Steel magnate, over a glass of cold water, when he retaliated with this cute piece of folklore: A bright but uneducated lad in an oil producing concern had manned the lease shipping pump faithfully and well over a long period of time, and was finally rewarded with the classification of "engineer". He promptly joined the local engineering society, and when the boss asked him how he had fared at his first meeting, he replied, "Shucks, chief! There was nothing to it. I felt a bit lost in the beginning all right, but in no time at all I was talking 'chrome Canadian steel and cuban feet' with the best of them." Incidentally, Earl is a young, spry individual who doesn't look the least bit historical, but Lin Little tells us that he and Earl were rivals for the hand of the same lassie up in the San Joaquin Valley way back in the days of the Aztecs or something. Stonishing, ain't it?

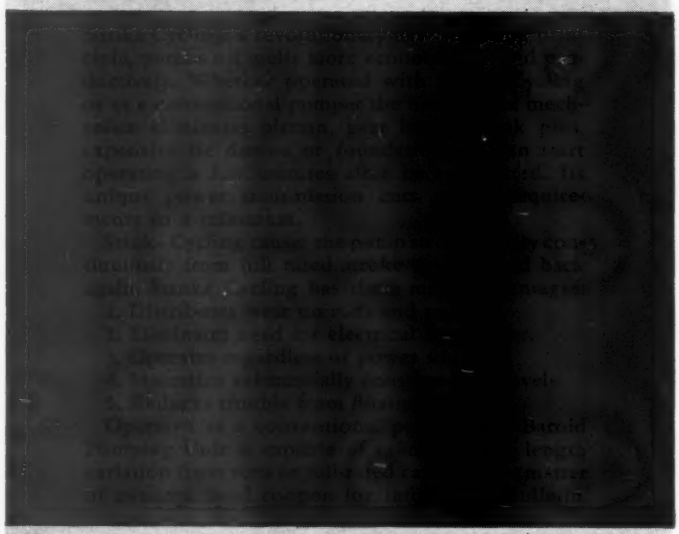
Our Mid-Continent eye, Marsh Fagin, is all of a twitter this month over a recent sashay into the higher reaches of petrolic socialdom. It seems that Magnolia Pipe Line Company, a sizable institution back yonder, helt a grand barbecue and whing ding in the colorful village of Patoka, on July 10. The affair was arranged to celebrate the completion of the company's 650 mile, 20-in. pipe line between Corsicana, Texas, the birthplace of the rotary drill, and Patoka, Illinois, a nice sounding bailiwick that will undoubtedly be famous from now on for this particular donnybrook. Our reporter dutifully rose in the dead of night and traveled by plane from Dallas with a formidable representation of Texas scribes and the following Magnolians: Bob Carter—advertising mogul, better informed on space than Albert Einstein; Ed Downing and Frank Faulkner, a duet that knows the producing art so intimately, either one of them could bring in a well with a ball and peen hammer and a cold chisel; Red Glover, pipe line genius who subsists solely on dynes and poises, and has supervised the pumping of enough oil to feed the eternal fires of he—ades (Goodness, what we nearly said!); safety conscious Bill Kent—he even hates golf hazards and is the world's greatest booster for artificial perspiration; Bill Maddox, the traffic whiz—sends shipments by car and cargo by ships; J. G. Meredith, figure adder upper—has yet to misplace his first decimal point; Fred Moore—a sedimental sort of a chap who takes a lot for granite; Guy Tate, sales exec—skilled in the art of selling goods that won't come back to people who will; John Terrell, top wooer of public goodwill—believes the best way to stay out of the red is to treat people white; Sherry Thompson, vice prexy in charge of lands and exploration—one of the industry's best ground gainers; Bob Chan, executive vice president—a man who has climbed the heights and still remains on the level.

This galaxy of petrolic luminaries was joined in Patoka by other oil men quite as luminous from widely scattered areas, and the ceremony from all accounts was a pretty lush affair. It was perhaps enjoyed most of all by J. L. "Slats" Latimer, president of Magnolia, who really fathered the pipe line project from its inception. Vice President Leslie True, however, was also obviously having a good time as he broke the oratorical ice and introduced Fayette Dow, general counsel of the National Petroleum Association. The latter in turn presented Col. J. Monroe Johnson, director of the Office of Defense Trans-

introducing . . .

BAROID STROKE CYCLING PUMPING UNIT





BAROID SALES DIVISION—SPECIALTIES DEPT.
National Lead Company
City National Bank Bldg., Houston 2, Texas

Gentlemen:
Please send me a copy of your new illustrated bulletin on the "BAROID STROKE CYCLING PUMPING UNIT"

Name_____Title_____

Company_____

Street_____

City_____Zone_____State_____

BAROID SALES DIVISION
NATIONAL LEAD COMPANY
LOS ANGELES 12 • TULSA 3 • HOUSTON 2

portation, member of the Interstate Commerce Commission, and the speaker of the day. Colonel Johnson did an elegant job of expounding the virtues of the new pipe line, and pointing out its importance in the prevention of future fuel oil shortages in the territory that it was to serve. One especially interesting interlude occurred when he inadvertently referred to the capacity of the line as 100,000 *gallons* and was immediately pounced upon by about two-thirds of the audience. He proved well able to take care of himself and the net result of his *lapsus linguae* was that he added a group of new names to the already considerable roster of his friends. The entire affair, including the barbecue was tops. Everyone had a grand time. The flying group returned to Dallas on the Braniff DC-3, undismayed by an electric storm that pushed them around a bit on the way home, and hoping feverently that Magnolia would soon complete another project that might require some further celebrating.

Colonel T. H. Barton, chairman of the board of Lion Oil Refining Company, El Dorado, Arkansas, made a decided hit recently when he gave the Petroleum Engineers' Club of Dallas the lowdown on engineering trends and applications in the oil business. The Lion company, itself a pioneer in the synthesis of chemicals from petroleum, is engaged in the large scale manufacture of ammonium nitrate from natural gas. Incidentally, the Colonel did such a nice job of dissertating on an exceedingly interesting topic that he was elected to honorary membership in the club, and is now entitled to be known as Doctor Barton. The report doesn't say whether or not he may write prescriptions. Anyway, it reminds us that a physician in the Mid-Continent leased his residential property to a producing company some time ago for drilling purposes. The very first well that was drilled on the place came in for 500 bbl a day, and now the doctor is making more money from the well than the sick. Tsk! Tsk! However, our hearty congratulations to Doctor Barton, and long may he continue to return to the good earth in richer and more assimilable form at least part of that which he has taken away. Recent visitors at the Lion plant at El Dorado, as guests of Johnnie Howell, vice president of production, were the Eye, George Cannon, Humbletonian from Houston, and Kenny Giest, from Allis-Chalmers at Milwaukee, where beer cans bloom in profusion and there are more hops than you'd find on a frog farm. They were vastly impressed at the way Johnnie Howell puts the Lion through his paces, and came away simply bubbling over with information and approbation.

For the moment skipping hither and yon, we have an interesting postcard from Homer Kidwell, erstwhile chief field clerk for Standard of California. It comes from Honolulu and depicts a number of young ladies, dressed becomingly in some wisps of long grass. At the suggestion of his old boss, Lin Little, we are accepting small donations for the purpose of buying Homer a scythe. He says it is warmer down there than it is in California and people don't wear so many clothes, as if he needed to tell us after that postcard. Homer returns in September just in time to take in the next Petroleum Production Pioneers' fandango at Ventura. A letter also from Doc Curtis, the Brea oil field surgeon, now down in Quito, Ecuador, with the Institute of Inter-American affairs. He is a good friend of Mr. Fletcher, superintendent of Shell Oil Company, who is in charge of drilling down in the Oriente. They want oil pretty badly in Ecuador, he tells us, and Shell is making a heroic effort to find it. He also adds that Mr. Fletcher is a devoted reader of *The Petroleum Engineer*, which certainly places him on a high intellectual plane.

And still on the subject of foreign affairs, we hear tell that Ford Alexander went down to Mexico recently to handle the biggest shot ever exploded in a well. We have been listening carefully with one ear cupped but haven't heard a thing yet. Lou Bronzan, the Baash-Ross biggie, left a short time ago for a tour of the Rocky Mountain states, and thence to Alberta, Canada, where he expected to visit Calgary and Edmonton. He was scheduled to meet Inky Wotkyns at Denver and Frank Bergeron at Casper, Wyoming. Before returning home, Lou, Mrs. Bronzan, and son, John, had planned to holiday at Banff and Lake Louise in the heart of the Canadian Rockies. We ran into another foreigner at the Nomads' Whing Ding, namely Charlie Schneider, the one time Tide Water Associated impresario, now doing business down Mexico way. Charlie was

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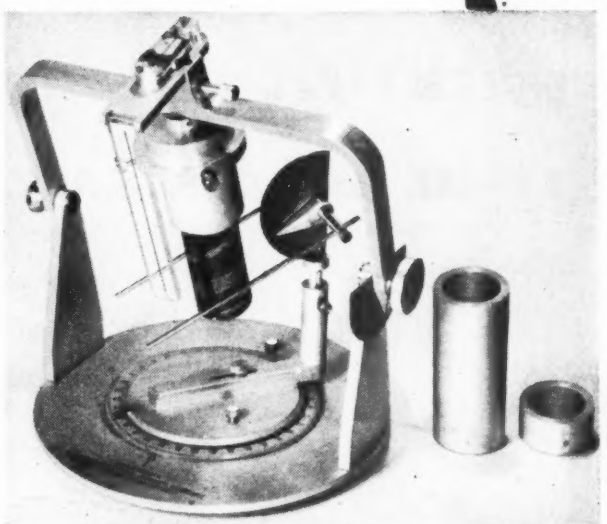

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here briefly to visit with Holly Hayter who has been having quite a serious illness. We sincerely hope that by this time Holly is back on the beam again. Don Rowe, Servicio Thomas, in San Tome, East Venezuela, has been seen at several local functions in the last two or three weeks. Last time we talked to him he wasn't quite sure whether he would go back down below or not. Don was with M. O. Johnston for about 5 years before he went to Venezuela, and before that put in 7 years with Signal Oil & Gas. He likes to hunt and fish—his favorite type of hunting being the hunting of good places from which to fish. He has a boy in the Navy and a girl at Tucson University. It has nothing to do with the case in point but we know a lad who got a B.S. and an M.A. but it's his P.A. has to support him.

Waxing scientific again, A. C. Bulnes, reservoir engineer for Shell Oil Company at Midland, Texas, spoke at a meeting of the Permian Basin chapter of AIME on the interpretation of core analysis data. The meeting was held in a small barn at Ector County Park, near Odessa, Texas, much to the disgust of the cows that had been evicted temporarily. More than a hundred engineers with straw in their hair crowded into the place for refreshments and the barbecue dinner that preceded the program. It is believed that without exception every core analysis expert in West Texas was on hand to take part in the lively discussion that followed the reading of this excellent paper. Besides developing some very interesting field data, it was concluded, because of the generous consumption of liquid refreshment, that core engineers as a class are more than usually permeable.

Another chap who probes unremittingly into the mysteries of the subsurface is Dale Rowden, consulting geologist of San Antonio, Texas. He recently took on the East Texas section of AIME and geologists from the same area, in the Blue Room of the Kilgore Hotel, and reviewed the physical properties of reservoir waters as casually as if he bathed in them daily. By the way, the name Blue Room has nothing whatever to do with the character of the stories that are told prior to the meetings. One never talks about an audience being "wowed" or "laid in the aisles" at a scientific meeting, but it would certainly be putting it mildly to say that this here presentation reduced the attending petroleum engineers and rock chippers to a completely horizontal plane. A petroleum engineer, we should perhaps point out, is a lad who has seen a drilling rig, and a rock chipper is an academic joe who scorns the use of words with less than four syllables.

Back tracking briefly, here is a thumbnail biog of a right suave chappie from the more elevated boulevards of Los Angeles—Jerry Engstrand. He was born in Illinois, received his primary education in Sweden, near Gottenburg, and wound up studying medicine at the University of Colorado at Denver. He played college football; was a hotshot 440-yard man. Played professional football for a year at Honolulu and then came to California. Attended USC—SAE fraternity; stayed in the frat house on the campus for 5 years, studying engineering at night. Was stockholder in the Olympic Corporation along with such celebrities as William Randolph Hearst, Marion Davies, H. F. Alexander, Logan & Bryan, and Stanley Dollar. Drilled four wells out in the Calabasas area. They were dry, but they gave him an idea—"get into the mud business." He did. Acquired a mud company with plants at Bakersfield, Rosamond and Los Angeles. Joined up with Grant Oil Tools as assistant to the president in 1941. Was recently elected to the board of directors of the Jonathan Club of Los Angeles, of which he has been a member for 13 years. He has traveled extensively—all over Europe and the central Americas, and has been in and out of the Latin-American countries so many times he has lost count. He has always maintained an active interest in sports, particularly football, badminton, squash, and track. On his last trip to South America, he was named special emissary to all the Latin-Americas to extend an official invitation to participate in the Olympic Games, going on as we write in London, England. He has in this connection interviewed every dignitary in the countries south of the border. When in Washington, he consorts with Admiral Jocko Clark of Okinawa fame, Secretary Forrestal, and people of that ilk. He has been a Nomad for 5 years—a director of the Los Angeles chapter for the past two years. He lives at the Jonathan Club, and gets more mysterious phone calls than Scotland Yard.

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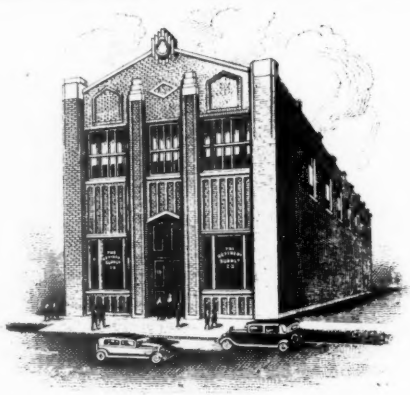

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And as we complete another amazing collection of petroddities, we are pleased no end to be able to report that Continental Oil Company's California land manager, Olen Lane, is again able to see in a forward direction. Olen watched a balloon ascension so long and so earnestly at the Rose Bowl on the night of July fourth that his head stuck at the 45 degree elevation. He is finding it very interesting to be able to see things at ground level again.

McKinney executive vice president

Arthur W. McKinney of Toledo, vice president and general manager of sales of The National Supply Company, has been elected to the newly created position of executive vice president of the company. McKinney joined National Supply as a salesman in 1920 shortly after his discharge from the Army, in which he served as a lieutenant in the Signal Corps. He rose through various sales positions to become vice president and general manager of sales in 1940.

A. W. McKinney

A specialist in petroleum problems, McKinney held advisory positions in that field during World War II, serving as a member of Industry Advisory Council, Petroleum Administration for War, and member of Materials Subcommittee, Petroleum Industry War Council.

McKinney is a director of the American Petroleum Institute and was recently appointed a member of the National Petroleum Council by J. A. Krug, Secretary of the Interior. A few weeks ago he was elected president of the Petroleum Equipment Suppliers Association. He is a director of The National Supply Company, Oil Well Engineering Company, Ltd., Cheadle Heath, England, and Ohio Citizens Trust Company, Toledo, Ohio.

L.A. Nomads Whing Ding

The attendance at the Los Angeles chapter of Nomads Whing Ding at the Lakewood Country Club, Long Beach, July 17, may have been slightly under the record peak set last year, but everybody had a spanking good time nonetheless. Golfing, horse shoe pitching, and gaming kept the members and their guests well occupied during the daylight hours, and the evening was devoted to a fine dinner, presentation of prizes, and a big time floor show.

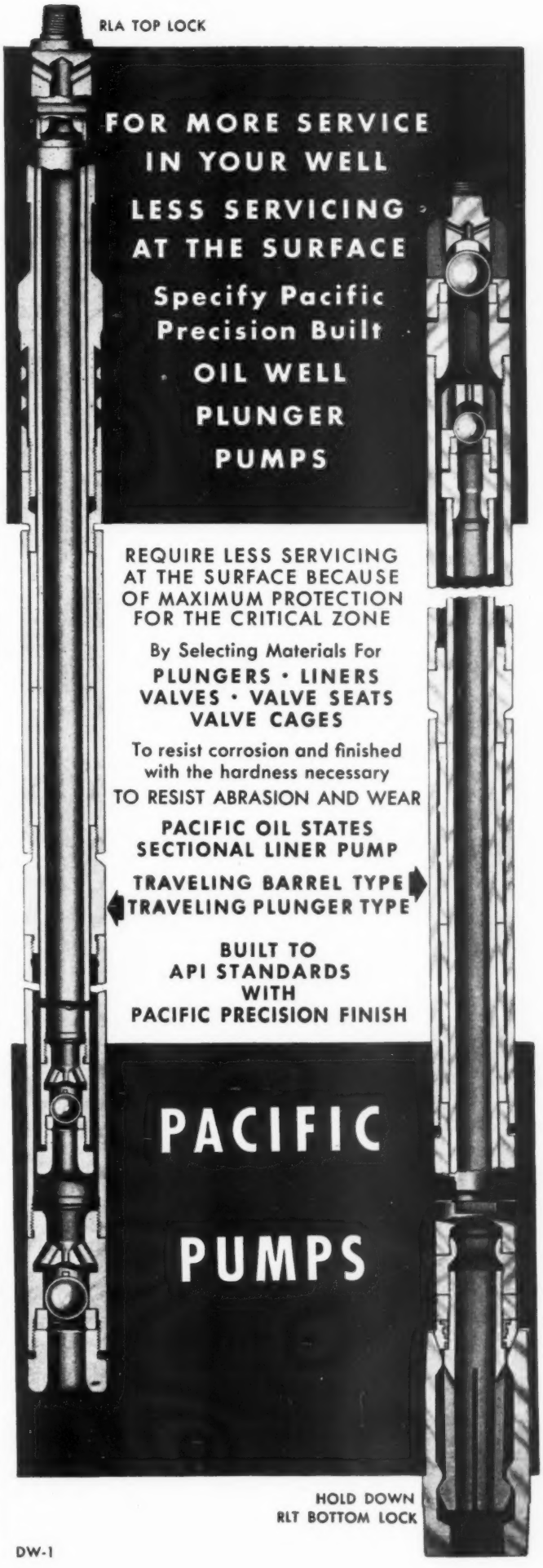
Fred Ripley, Jr., president of the chapter, made the presentation of prizes, for the selection of which credit goes to George Anderson and Babe Doyle. Ray Humphreys was unable to be present because of a date with a surgeon. (Late reports are that he is almost fully recovered). In any case Joe Siegel took over as croupier of Little Monte Carlo, and with a staff of helpers kept things rolling along smoothly. The golf was in the capable hands of George "The Shirt" Trembley, and his three faithfuls—Joe Schlarb, Bill Wilson, and John Rife. The horse shoe pitchers were steered by expert Abe Haglund, and hence enjoyed themselves thoroughly. The entire affair, indeed, including the show, which was largely arranged by Earle Boggess, went off in fine style. There was a sizeable representation of foreign visitors, and the locals appeared to take excellent care of them.

New CNGA lead

The annual meeting of the board of directors of the California Natural Gasoline Association, held in July, was the occasion for the formal transfer of leadership of the association to W. A. Kirk, California Southern Oil Company by Frank J. Colton, Tide Water Associated Oil Company, retiring president.

Kirk joined CNGA soon after its inception and has been active in its work since 1926. Having served on the board of directors for the last 15 years and in the capacity of vice president for the last year.

Other officers elected were: J. B. Taylor, Signal Oil and Gas Company, vice president; Paul Armstrong, sales engineer; F. E. Bradley, CCMO; R. O. Boykin, Fullerton Oil Company; L. P. Foote,Petrolane, Ltd.; R. E. Foss, Barnsdall Oil Company; N. A. Rousselot, Seaboard Oil Company and Leland K. Whittier, Belridge Oil Company, as directors. E. R. Millett, Jr., was reappointed secretary-treasurer.



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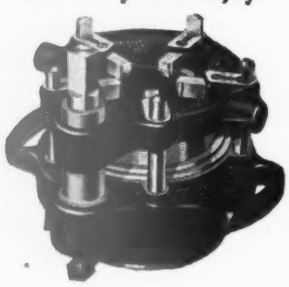

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● **An Index to Chemical and Related Subjects, 1947,** *compiled by Luis Hilt, E. Holley Poe and Associates. American Gas Association, 420 Lexington Avenue, New York 17. Pages, 114. Price. $1.50.*

A useful index covering publications of the gas industry not ordinarily indexed or abstracted in the scientific literature. An aid in locating articles and papers on chemical subjects presented at various Association meetings, this is an up-to-date addition to the 1936 index.

Hilt's experience as Librarian at the AGA headquarters enabled him to put the references into a form, with subject and author divisions and appropriate cross references, to provide great facility to those using the book.

● **A History of the Petroleum Administration for War, 1941-1945,** *prepared by John W. Frey and H. Chandler Ide. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Pages, 463. Price, $3.*

This is a history dealing with an unprecedented program of Government-industry cooperation. It records the manifold activities of the wartime operations of the combination and reveals how demands for petroleum products were met in full despite the handicaps of wartime shortages of materials and manpower and despite the necessity for speed. The evolution of the oil agency itself is described as is the evolution of the industry side of the partnership. Because of the necessity of condensation, parts of the story have been selected to best show the general policies, patterns and trends, and personalities have been avoided entirely.

● **Electrical Engineering, Problems and Their Solutions,** *by T. F. Wall. Chemical Publishing Company, 26 Court Street, Brooklyn 2, New York. Pages 312. Price $5.*

In detailed, step-by-step description, solutions to problems from the whole range of applied electricity and magnetism have been drawn. Questions and answers taken from actual practice form a valuable guide in the actual working out of problems. Examples have been chosen and arranged to emphasize different aspects of the principles dealt with in the companion volume, *Principles of Electrical Engineering,* and to clarify points that might otherwise be obscure. While most of the problems can be solved with a minimum effort, a considerable number will extend the faculties of the most brilliant to work out solutions in full detail.

● **Gas Facts, 1945 and 1946,** *by the American Gas Association—Bureau of Statistics, 420 Lexington Avenue, New York 17. Pages, 166. Price, $1.*

A statistical record of the gas utility industry in the United States has been published by the American Gas Association's Bureau of Statistics. The comprehensive tables cover energy reserves, production, transmission and distribution, sales and utilization, finance, labor and prices. This is the first edition of the volume, which will be published annually hereafter. It is probably the most complete collection of its kind that has been made in the gas industry.

● **Jet Propulsion Progress,** *by Leslie E. Neville and Nathaniel F. Silsbee. McGraw-Hill Book Company, 330 West 42nd Street, New York 18. Pages, 232. Price, $3.50.*

Here is the absorbing story of the revolutionary power plant —the gas turbine, known also as the turbo jet or turbo prop. The report presents simply and accurately the fundamentals of the gas turbine as applied to aircraft, with an outline of the development of such units in Germany, Great Britain, and the United States. Although a considerable amount of technical material has been included, elaborate calculations, engineering formulas and highly technical discussions have been largely avoided. This volume should prove of interest to all who are concerned with the problems of the new air age.

Louis Mason promoted

Louis W. Mason has been appointed assistant to the general manager of sales of National Tube Company, it is announced by H. J. Wallace, general manager of sales of this United States Steel subsidiary. Mason has been Pittsburgh district manager of sales for the company. Succeeding Mason as manager of National Tube's Pittsburgh sales office is Henry C. Hoar, formerly manager of sales at St. Louis.

Louis W. Mason

Mason was first employed by National Tube in 1923 in the purchasing department, eventually becoming assistant purchasing agent. He became manager of purchases for the Tubular Alloy Steel Corporation in Gary, Indiana, during the wartime period. He later joined the sales department of National Tube in Washington, D. C., and went to Pittsburgh in 1946 as district manager of sales.

Hoar, a graduate of Massachusetts Institute of Technology, joined National Tube in 1927. He served in various capacities in the sales department and became manager of sales at St. Louis in 1946.

Glendon P. Robb succeeds Hoar as manager of sales in St. Louis.

Manager press service

Hobart C. McDaniel has been appointed manager, Technical Press Service in the Public Relations Department of Westinghouse Electric Corporation, Pittsburgh, Pennsylvania. McDaniel will be responsible for the company's publicity in the technical and trade magazines.

He succeeds Carl E. Nagel who has resigned to join McGraw-Hill Book Company in New York as editor of mail sales books for the engineering and industrial fields.

McDaniel was graduated in electrical engineering from Oregon State College, Corvallis, Oregon, in 1926. He went with the Westinghouse Lamp Division in Bloomfield, New Jersey, as commercial engineer in 1939 after working with Pacific Power and Light Company, Portland, Oregon, and Central Illinois Public Service Company, Springfield, Illinois, as a lighting sales engineer. In 1943 he joined the Technical Press Service in the Pittsburgh office.

Foster Wheeler changes

Foster Wheeler Corporation has announced three changes in its sales staff. H. B. Wallace Jr., has been appointed manager of steam sales for the corporation. He had been manager of the New England territory in Boston since his return from the armed service.

A. F. Downham has been appointed manager of the New England territory succeeding Wallace. Downham was formerly in the sales department of the Pittsburgh office.

W. H. Hardie has become associated with the New York Sales office and will concentrate on the sales of steam generators, pulverizers, superheaters, and related products.

Sperry-Sun general manager

Appointment of Arthur B. Palmer as general manager of the Sperry-Sun Well Surveying Company is announced by Samuel H. Williston, vice president and director.

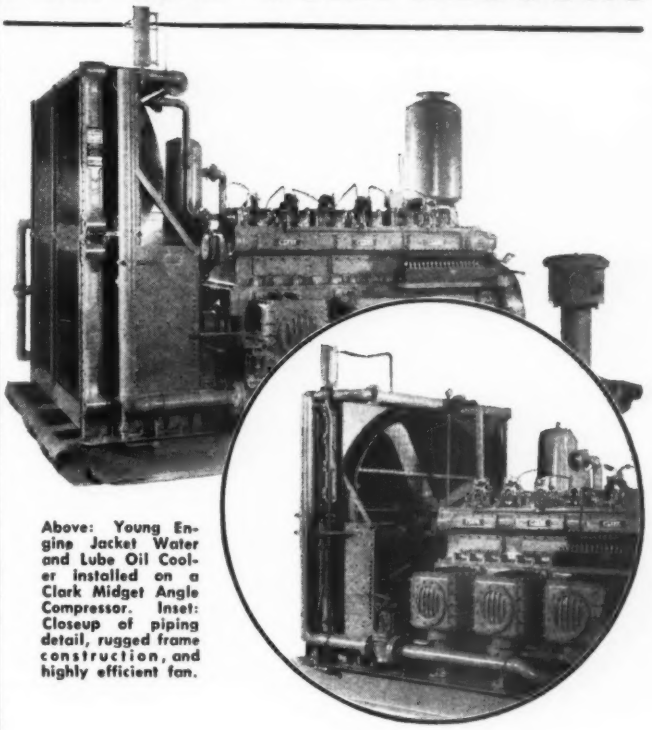
Palmer joined the parent Sun Oil Company as an engineer at Maracaibo, Venezuela, in 1922, immediately after his graduation from the University of Illinois where he received a degree in civil engineering.

He joined Sperry-Sun as a sales and service engineer in 1929. In 1938 he was named district manager for the company and since August, 1947, he has served as general sales manager with headquarters at Houston, Texas.

Foxboro enlarges quarters

Having acquired the remaining space in the building that it occupies at 266 Fremont Street, the San Francisco branch of The Foxboro Company is now settled in its rearranged quarters, with practically double the working space previously available. The San Francisco branch is a sales office and warehouse for Foxboro products, and also a branch factory, providing repair service for customers in the West Coast territory.

MULTIPLE COOLING FOR GAS COMPRESSORS



Above: Young Engine Jacket Water and Lube Oil Cooler installed on a Clark Midget Angle Compressor. Inset: Closeup of piping detail, rugged frame construction, and highly efficient fan.

● Portable gas compressors call for compact cooling units. Standard Young Jacket Water Coolers are the favorite heat transfer units in the field or at the refinery because they are specially developed for the equipment they serve. In addition to cooling jacket water and lube oil, Young Units are available for gas cooling between stages, making possible a complete, engineered cooling system from a single manufacturer.

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California drilling contractors meet

The California chapter of AAODC met at Scully's Cafe in Los Angeles, on Thursday evening, July 15, with A. S. "Doc" Hayes presiding and a generous representation of members and friends listening in. Doc announced early in the proceedings that the mud classes at Long Beach had been discontinued until September 13 due to vacations mostly, and that a new plan of handling was projected for future classes. It is proposed that hereafter applications be made through the employer so that where necessary the applicant may be aided through a rearrangement of working shift, or by the adjustment of other matters that may interfere with the educational process. New instructors have been obtained and a new method of handling the classes will be tried—each instructor conducting a class for two weeks.

The chairman also announced that Long Beach Junior College was instituting a two-year course in drilling practice, beginning in September; that Bakersfield would probably do likewise, beginning in February, 1949. Through these plans it was the expressed hope that the industry would be provided with well qualified personnel to break into drilling and tool pushing jobs. State educational authorities, it was intimated, are also becoming interested in AAODC plans, and have arranged a meeting to determine the educational needs of the drilling industry, and to discuss naming a coordinator.

There then followed a sort of round table debate on the questionnaire that had been mailed out to members by the cost committee. Chiefly implicated in developing the purposes and defining the requirements of this document was Dick Pettijohn, who succeeded nicely. It was eventually pointed out that each member should do his best to turn in accurate figures where they were available—since the ultimate intent of the inquiry was to set up average costs that would be a worthwhile guide for all concerned.

A committee was appointed to determine whether the contractors might be able to obtain insurance under some type of group plan. Named on this committee were J. H. Harris, San Joaquin Drilling Company, chairman; D. N. Lewis, Rocky Mt. Drilling Company; J. K. Kellogg, Kellogg and Sons; R. V. Towner, Brown Drilling Company; E. R. Love, Camay Drilling Company; G. H. McCarthy, Shamrock Drilling Company; Lee Daniel, Loffland Brothers; C. E. Rieman, Pike Drilling Company; H. H. Hillman, California Production Service; Walter Scott, Santa Fe Drilling Company; E. J. Simonis, Santa Maria Drilling Company; Tine Gaiser, contract driller.

Doug Graham, national vice president for California, next gave a report on the highlights of the Denver meeting of the AAODC board of directors. He particularly lauded Ned Brown for his excellent work as president of the national. Then, he announced that there are at the present time some 2200 domestic rotary rigs in operation, which is about 400 higher than at the same time in 1947. Tubular goods, he predicted, would be at least as plentiful as they have been this year. He remarked also that about 3500 men had so far been graduated from the AAODC sponsored mud classes. Other important matters on the Denver agenda were a move to promote a really intensive membership drive; stimulation of the safety program; the institution of a code of ethics, and consideration of the GMC diesel courses that are being offered to mechanics in Houston, and may be offered here. Doug revealed the interesting fact that Secretary Frank Jones of the local chapter had been elected to revise University of Texas' Manual of Rotary Drilling Practice, which had been originally compiled some eight or ten years ago.

When the meeting had adjourned, Chris Christanelli, and Eddie Duchin Lelke, of Baroid, took over and turned the balance of the evening into a musicale that had more volume than virtuosity. Both these gentlemen are excellent performers, but they were generously aided by a number of people who had evidently squandered their time drilling wells and sadly neglected voice culture despite its importance socially.

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Three new divisions

Climaxing a concentrated effort to effect faster and more widespread service in supplying the drilling industry with a convenient, singular source of drilling muds, chemicals and mud handling equipment, Mud Products Inc., of Tulsa, Oklahoma, recently announced the organization of three separate divisions, it has been announced by the firm's general manager. E. R. "Dick" Albert, Jr.

The three new divisions of the company, according to Albert, will include the mud sales division, handling mud and chemicals only, the mud equipment division, selling and servicing mud handling equipment exclusively, and the export division, which will handle the sales and service of both mud and equipment in foreign countries.

Mud Products, Inc., now have 12 modernized warehouses in the Mid-Continent area, and operate a large fleet of supply trucks on duty 24 hours a day. In conjunction with its supply service, mud equipment engineers are available to offer counsel and engineering advice on mud equipment problems.

ASTM Index issued

American Society for Testing Materials has issued the revised "Index to ASTM Standards," as of December, 1947. This publication issued in May, 1948, is really an adjunct to the 1946 Book of Standards (6600 pages) and the 1947 Supplements (1800 pages), and enables any of the some 1500 standard specifications and tests in the volumes to be found readily. The Index is also of service to those who wish to determine whether ASTM has issued standard specifications, test methods, or definitions covering a particular engineering subject.

All items are listed in the Index under appropriate keywords according to the particular subjects they cover. As a convenience a list is given of the specifications and tests in numeric sequence of their serial designations.

Copies of the 240-page publication are supplied without charge on written request to ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pennsylvania, it is announced.

Treasurer Continental Oil

A. W. Tarkington, of Tulsa, Oklahoma, joined Continental Oil Company on August 16 as treasurer of the company. In assuming his new position Tarkington, who was formerly assistant treasurer of Bethlehem Supply Company, Tulsa, became one of the youngest top-flight officials of a major oil company in the United States. He has just passed his thirty-seventh birthday.

New Failing sales manager

Recent changes in the sales department of the Geo. E. Failing Supply Company, Enid, Oklahoma, manufacturers of portable oil field drilling and exploration equipment include the naming of Walt Buller as general sales manager and Jack Boyd as his assistant.

Buller has been with the Failing company since 1936, beginning as secretary to the plant manager. During the war he was

Walt Buller (left) and Jack Boyd

priorities manager and expediter of incoming materials and since the war he has been serving as assistant sales manager. He is 31 years of age.

Jack Boyd, who was graduated from Oklahoma A. and M. College in 1946 with a B.S. Degree, began work with the Failing company in 1946 in the parts department. A year later he was transferred to the sales department. He is 26 years of age.

Welding divisions moved

The first complete large-scale welding equipment business to be located entirely within the New England states was completed recently when final components of the General Electric Company's welding equipment divisions moved to Fitchburg, Massachusetts, it is announced by C. I. MacGuffie, welding equipment divisions sales manager.

The sales and application engineering division of the welding equipment divisions have now joined the d-c. welder manufacturing plant in Fitchburg. This move, coupled with the prior establishment of the a-c. welder factory in Holyoke, Massachusetts, makes New England one of the major arc welding centers of the world.

Under the new organization, sale of G-E welding products for the entire New England area will be handled by the Welding Engineering Sales Corporation, Boston, Massachusetts. In addition, portions of western Massachusetts, Maine, Vermont, and New Hampshire also will be served by direct factory sales from General Electric arc welding headquarters in Fitchburg.

The General Electric line of welding products to be sold and serviced from the new location is composed of a-c. welders, including inert-arc and atomic-hydrogen welders, d-c. welders, and automatic machine welding equipment. G-E welding electrodes and accessories also will be sold from the Fitchburg office.

Manager new division

Benjamin Brewster has been appointed to the newly created position of manager of the Technical Service Division of the Ethyl Corporation Research Laboratories in Detroit, according to an announcement by Richard K. Scales, director of technical service. The Technical Service Division is the liaison group between the Ethyl Laboratories and oil company research departments, and automotive and farm equipment manufacturers.

As manager of technical service, Brewster will have direct responsibility for carrying out projects planned by Scales and his staff. He will also continue as a member of the technical representatives group, which maintains contact between the Ethyl Laboratories and oil company research laboratories.

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